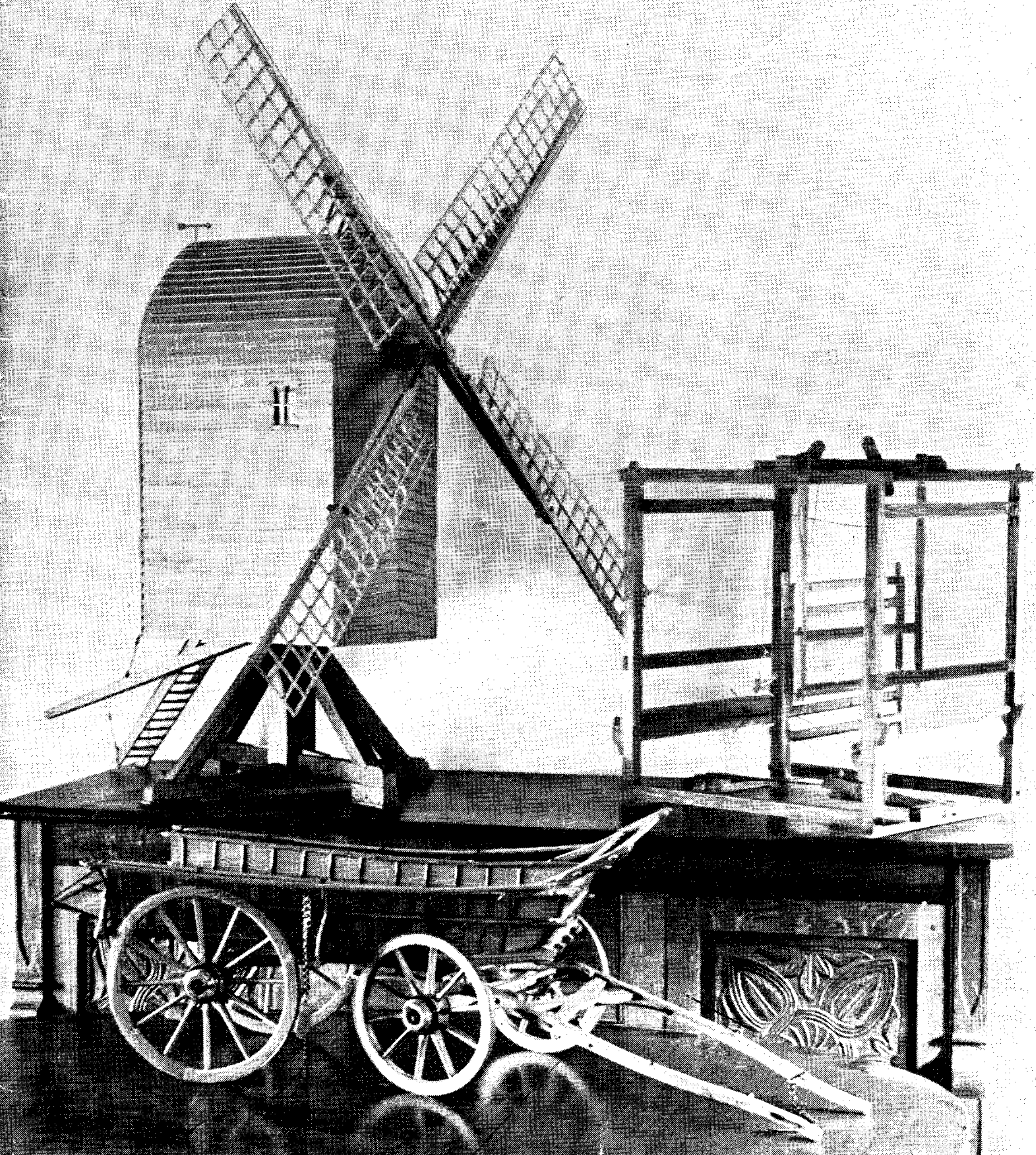
Vol. 104 No. 2603 THURSDAY APRIL 12 1951 9d.

THE MODEL ENGINEER



The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

12TH APRIL 1951 VOL. 104 NO. 2603

SMOKE RINGS

Our Cover Picture

● IT WAS the poet Cowper who wrote: "Variety's the very spice of life," and the phrase is, of course, very true. But we think that our cover picture this week shows the well-known phrase translated into solid matter, for it depicts part of a sideboard together with models of a windmill, a loom and a farm wagon, the work of Mr. T. H. Coles, of Banbury.

They are made of old timber, some of which may be hundreds of years old. We could wish that more of the sideboard were visible, because what can be seen reveals very nice work. The wagon is a model of an Oxfordshire wagon to 2-in. scale, and another photograph of it is reproduced on this page. Incidentally, we wonder if many of our readers are aware that each of the English counties had its own distinctive design of farm wagon.

The windmill is made to 1-in. scale and shows neat work put into a picturesque model.

The loom is to 2-in. scale and is capable of weaving work 10 in. wide.

The photographs are by Blinkhorns, Banbury.

Horse of a Different Colour

● IN THE course of the correspondence arising out of the little locomotive on Canvey Island, several readers have recalled that, about 1904, there was a *kind* of railway on the island. A single rail was laid from a point near Benfleet to the other end of the island. On this rail a *two*-wheeled car was run; it was fitted with a pole, or shaft, projecting from one side, and to the outer end of this shaft was attached the means whereby the car was held upright and provided with motive-power—to wit, a *horse*!

Apparently, this form of transport, concerning which the degree of comfort experienced by the passengers is rather open to question, did not last very long, because, a little later, a normal two-rail track was laid for use with single-deck, electrically-operated cars. The line was completed and the cars were delivered, but the sponsors went bankrupt. The track was taken up and sold by the contractor to defray his expenses.

The foundations of what was to have been the power station for this scheme can still be seen.

Festival of Britain Exhibition at Billericay

● THE BILLERICAY Society of Model Engineers has decided to make a really special effort to ensure that the forthcoming exhibition, to be held at the Women's Institute, High Street, Billericay, Essex, from May 3rd to 5th, is worthy of the Festival of Britain year.

We have been favoured with an advance copy of the catalogue, and from it we note there is to be a special feature entitled "Billericay Through the Years," to depict something of the history of the town during the 2,000 years which have passed since pre-Roman days. The town and its surrounding country have a most interesting, if occasionally grim history, which will be recalled in the various photographs, pictures, documents and other relics which will be on show; but the main exhibit in this section will be a model of the town as it was up to about 1935, since when some alterations have been made to the place.

The main exhibition will cover: Railways; locomotives; rolling stock; an automatic penny-in-the-slot underground railway; historic machine tools; architectural models; water transport; steam, petrol and diesel engines; a gyroscope; an ever-running tap; aircraft, and displays by the Billericay Youth Centre, Brentwood and District Model Engineering Society, Chelmsford Society of Model Engineers and the 29th East Ham Scout Group.

Traction Engine Photographs

● WE HAVE received a list of photographs, of steam rollers and traction engines, which pleases us because of the fact that such photographs should become, at long last, permanently available to the growing number of traction engine enthusiasts. Such subjects as Aveling & Porter rollers, Boydell, Burrell, Foster, Fowler, Marshall, Wallis & Steevens and even unknown makes of traction engines are included; a section of the list is devoted to photo-reproductions of illustrations from Burrell's 1915 catalogue. In addition, two steam buses are listed and there are two views of a Cornish beam engine. We understand that further lists of interesting photographs of this kind are in preparation.

The list and photographs can be obtained from Locomotive & General Railway Photographs, Sales Section, 101, Talbot Road, Bristol, 4, who are to be congratulated upon this enterprise.

Cornish Pumping Engine Drawings

● WE HAVE received a letter from Mr. J. A. Pickles, managing director of Messrs. Hy. Brown, Sons & Pickles Ltd., Engineers, Wellhouse Works, Barnoldswick, via Colne, Lancs, who wrote to express interest in the photographs of the model Cornish pumping engine, published in our February 1st issue, and congratulating Mr. R. Jarvis on a very fine job.

Mr. Pickles added: "We have in our possession a complete set of working drawings for an engine of this type and size, 80 in. bore, 10 ft. stroke, which was built for the Trogollon Mine Co., Cornwall, in 1863, by a firm which is no longer in existence, Messrs. Bracewell & Griffiths, Burnley Ironworks, Burnley, Lancs. These drawings are large size and beautifully coloured, etc., and we shall be pleased to loan them to any of your readers who may be interested in them."

In acknowledging this very generous offer, we suggested that it might be possible for photostat copies to be made of the drawings, but the idea proves to be impracticable owing to their large size; they are in a roll which weighs about 14 lb., and the cost of copying them would be prohibitive. Besides, a model of a Cornish pump is not the kind which many model engineers would care to undertake. However, we have great pleasure in making known the handsome offer which Mr. Pickles has made, and we leave it to any genuinely interested reader to communicate with Mr. Pickles direct.

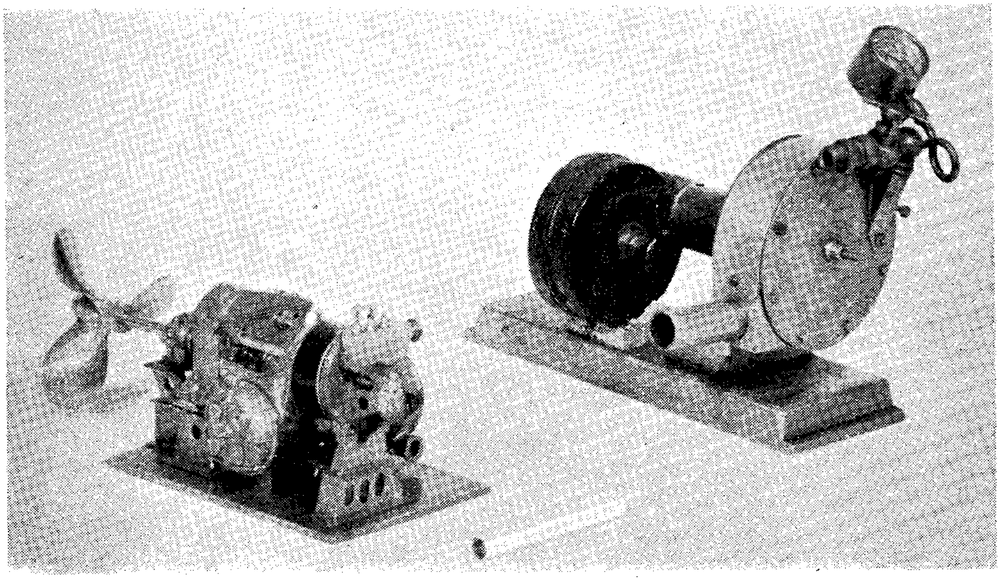
Soliciting Municipal Support

● MR. GEORGE TEESDALE, 57, Terrace Street, Blackheath, Birmingham, has written to us as follows:—"We have formed a committee composed of members from the following clubs, Blackheath Model Engineers' Club, Old Hill and District M.A.C., Quinton M.A.C., Halesowen M.A.C. The purpose of this committee being to organise the clubs in the district to unite together and form an association united with one object in view, that of giving to the public demonstrations of modelling generally, and to further give public exhibitions of the modellers' work constructed by its members. When we have achieved these objects, it will then become our main purpose to try and get the local council, namely, Rawley Regis Borough Council, to lay out in one of its parks, a track suitable for model engine constructors, a track suitable for model racing cars also a pitch suitable for model aero-flying. This, we feel, is a need which ought to be catered for because we are of the opinion that our styles are badly cramped because we cannot get a ground suitable for this purpose. To date, we have failed to get them to give us their blessing. There is no doubt that there is great entertainment value in modelling work."

A Small Double-Reduction Geared Marine Steam Turbine Unit

by Comdr. L. S. McCready, U.S.M.S.

As a marine engineer and a model engineering enthusiast, I have long been interested in steam turbines. They offer such a challenge to the builder, and even though there are few moving parts to be seen, unlike our popular steam engines, the thrill of operating a small steam turbine is there just the same.



A model double-reduction geared marine turbine on left, and a single-stage impulse turbine on right

At the same time, I have felt that models should resemble prototypes closely, so that the finished article at least had the characteristic appearance of the real thing in the main, if not in every last detail. It is true, none the less, that my first steam turbine, made in 1935, did not follow prototype design at all. But it ran well, and drove an a.c. generator and lighted a bulb. It is shown in the first photograph. It is simply a single-stage impulse turbine with 32 blades, the rotor being made from a thin copper disc, as shown in *Model Steamers and Motor Boats*. The blades themselves are cut radially, twisted, and then curved. It is still running, but there is a new turbine to describe now.

While convalescing in 1946 from an air crash, I decided to design a marine turbine unit that would be small, deliver appreciable power, resemble a real unit, and be reasonably efficient. It is surprising what a lot of power a small engine will produce if it is correctly designed; witness "L.B.S.C.", of course. So this turbine was to have only a 1 in. diameter rotor, and the rest in proportion. Since the only way to get power out of small turbines, generally speaking, is to rev them up to really high speeds, I set out getting a substantial reduction down to the propeller shaft. Finding on hand the works out of a very small clock, really no bigger than a large watch, I found two meshes that gave a 50 : 1 reduction, and then and there had my high-speed pinion, intermediate gears, and the low-speed "bull gear" to drive the propeller shaft. Four years later it was ready to run. It had not been worked on except now and then, however.

This unit was to have a condenser. Since the turbine had to look like a marine turbine and the gearbox like a marine gearbox, castings were in order. There are 13 castings in the turbine in all, and they are made of hard babbitt. A process new to me but old as antiquity in the art of the foundry is the "lost wax" process. This is widely used in dentistry, too, for making bridges, inlays and other work; in fact, it was a dentist friend who first acquainted me with the marvellous possibilities of the method, which can easily produce castings of utmost complexity.

The process will be described; it is highly recommended for model makers. In a nutshell,

the process first calls for a pattern made of *wax*. After carving or building up the pattern exactly as the finished casting is wanted, with absolutely *no* regard to such things as draft, parting, cores or other features of sand casting, we attach more wax in the shape of risers and sprue, as well as slender wax rods or strips arranged so as later to produce vents in the mould from high points on the pattern. The rule is "make it in wax *exactly* as you want it in metal." Next, we lower the whole into a small tin can container of thin plaster of paris or better still, dental investment plaster, which is a high-grade variety, as far as I can tell, of plaster of paris. The tin can should be large enough to accommodate the pattern plus some room to spare. We leave only the top of the wax stem or sprue sticking out, and the little vent-rods of wax. Actually, it is best to take a small brush and "paint" the pattern, especially in the crevices, with the plaster first, before immersing the whole pattern; this prevents air bubbles keeping the wet plaster from surrounding the exact form of the pattern. If bubbles do remain in the plaster next to the pattern, then we get cast-in blobs here and there on the finished casting. The plaster is allowed to set thoroughly.

The next step is to melt out the wax, and here the process is nearly done. We see that when the wax is melted out of the plaster, what remains is obviously a hollow space inside the plaster having precisely the same shape as our original wax pattern! Dentists then heat their plaster mould in a little electric furnace till the plaster gets red hot; the wax melts and vanishes, the last traces going up in smoke. Then while the mould is still red hot, they pour in their alloy, whether it be gold, silver, or vitallium (which is also used by the identical process, to make jet engine turbine blades nowadays—the vitallium is too hard to forge or machine by other methods). The dentists use centrifugal force to force the metal into every crevice, whirling the whole mould in a so-called centrifugal casting machine. The model maker can do without, and simply heat the mould carefully with a gas flame till all smoking of wax ceases—a lot of melted wax will boil out, and spill, too, in this step—and then pour in his metal.

Perfect Results

The thrill of the method comes when the mould is cool, and we commence digging in the plaster to find out what kind of a casting lies within! The plaster is carefully picked and cracked away, and we finally get our little casting. With any luck at all, the results will be perfect, and the casting will be a precise replica of the original wax pattern, showing every detail and scratch mark left on the wax; I speak of babbitt castings. I tried bronze once, but the exactness was a little lacking. The plaster will take bronze well, however. Now for the rub. If there has been revealed any flaw in the casting, the entire process has to be repeated in order to get another casting, since we have no pattern left. It went up in smoke!

Actually, I was very much pleased with the results I obtained. A few castings showed little beads of babbitt in unwanted places. These were from small air bubbles which remained next to the wax while the plaster was being worked around the pattern. The only other main fault is likely to be failure of the metal to fill every part of the mould. This comes either from the mould being too cool, improperly vented to let the metal rise up into high parts which otherwise would be air-bound, or from expecting too much metal to flow through too tiny a space, instead of providing adequate channels or gates by means of extra wax added to the pattern, the excess later being removed as part of the sprue metal, etc.

Casing and Cover

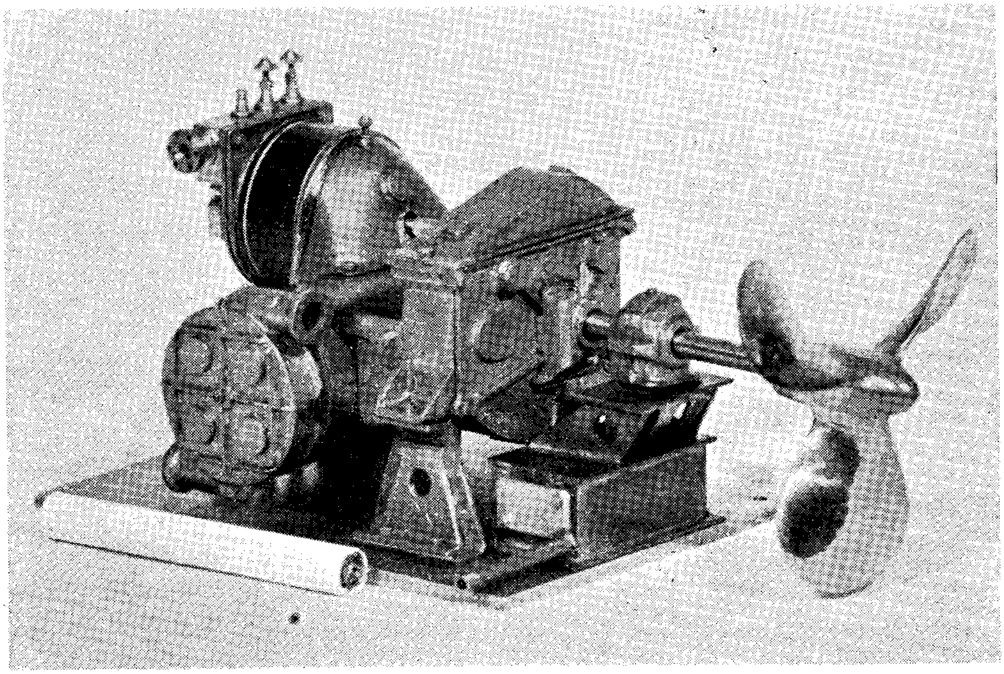
To get on with the turbine description, the photographs show the casing of the turbine and the cover, two castings which are bolted together with 0-8 bolts 0.060 in. diameter threaded 80 threads per inch. There are some smaller 00-90 bolts here and there, too! The turbine had to have a characteristic-looking curved exhaust trunk to the condenser inlet, so it was made as shown. The condenser is a regular marine design, being a two-pass affair. In other words, the sea water enters the lower inlet, flows to the other end through only the lower half of the tubes, makes a return bend inside the far water box, and comes back through the top half of the tubes and out via the overboard discharge. The water box where the sea water enters and leaves has to have a baffle, or division plate as it is called, and this is put horizontally across the midpoint. There are 88 tubes of $\frac{1}{16}$ in. thin wall brass tubing, yielding about 40 sq. in. of condensing surface, as the tubes are $2\frac{3}{8}$ in. long between the $\frac{1}{16}$ in. thick tube sheets. The water drops to a little hot-well, cast boxlike in form and arranged to fit the curvature of the condenser, and to form a kind of saddle for the mounting of the condenser. (Real condensers, however, do not sit on their hot-wells!)

The gearbox is really an outer cover, in the main, as the gears are fitted inside, running in their own brass frames and bearings. The whole process was one of "adaptation," which is so widely used by model makers in using things that come to hand. I dare say that many is the part that is made so because the stock or odd bit in the scrap box so dictated! Anyway, the clock was stripped of all the gears save the ones I wanted, and the frames trimmed down to fit inside my gearbox design. One trouble with using watch clock gears, well known to those who have tried, is that there are usually no shaft extensions for our use, and it is a dickens of a thing, as a rule, to adapt tiny pinions and gears so that they get extensions where we want them

Actually, in this job, I used another pinion found in a watchmaker's scrap box which chanced to mesh with my intermediate gear. The problem then was to fit this pinion on to the turbine shaft; it was done by pressing and soldering the pinion half into a brass sleeve, and fitting the brass sleeve to the shaft. The stub shaft of the pinion measured 0.035 in. and it had to be fitted with a microscopic bush to bring it up to 0.0394 in. which was needed to fit the inner ball-race in which it was to run. Again, unlike big turbines, which have babbitt bearings,

this little job has two tiny 0.167 in. diameter ball-bearings of Swiss make for the rotor bearings. They are Landis and Gyr bearings, and have six balls only 0.039 in. diameter, believe it or not. Also, they are rated at not over 12,000 r.p.m., which is only loafing speed for the turbine, so probably they are overloaded when the turbine is sizzling along. The inner frame assembly and also as the thrust bearing. The little clock gear was removed from its own shaft and pressed and soldered on a special shoulder turned on the propeller shaft. The clock frames were modified to take the $\frac{3}{8}$-in. race in a new bush at the forward frame, and the $\frac{3}{16}$-in. shaft at the after frame, from which the shaft projects, as shown.

The babbitt gearbox castings comprise the



A general view of the model turbine, with a cigarette in the foreground for comparison of size

needed only a carrier for the aft rotor ball-bearing, which has a little cup in which the bearing is pressed, and the mounting is held with two watch screws in slotted holes which allow for adjustment of the pinion mesh.

The intermediate gear turns about 1/7th turbine speed, and itself carries the low-speed pinion. This meshes with the bull gear, again about 7 to 1 reduction, the two reductions being just about 50 to one. Assuredly, a fifty to one reduction is quite a bit! There is no reason why a triple reduction could not have been used, which would allow perhaps still higher turbine speed, but ships do not use more than double reduction ; even so, they can reduce say 6,000 or 7,000 r.p.m. down to 100 or 110 of the shaft in two reductions in some designs.

The bull gear was given drastic treatment. The propeller shaft is $\frac{3}{16}$-in. drill rod, so the forward end was shouldered down to about $\frac{1}{8}$ in. to fit the inner race of another small ball-bearing, this time one having $\frac{3}{8}$ in. overall diameter, part of the inside from a Flying Fort altitude control. This ball-bearing serves as a bearing for the shaft main case, aft cover, top cover, and a boss where the shaft leaves the casing. Further along, the tailshaft runs in another bearing cast so as to resemble in form and arrangement a ship's thrust block of the Kingsbury or Mitchel design, in which the entire thrust is transmitted from one collar on the shaft to several flexibly-mounted shoes, but in this little turbine it is only a plain babbitt bearing for the shaft, the thrust being carried in the model by a ball-bearing previously mentioned. The dummy thrust block is mounted on a built-up foundation or support embodying in its design a small sump tank for drains from the gears, said sump tank playing a vital part in ships, for the oil is pumped out for recirculation after it has oiled the turbine and gears.

The rotor shaft is $\frac{1}{8}$-in. drill rod, shouldered down in two steps at the forward end to 0.0394 in. for the ball-bearing, and at the aft end for the pinion sleeve. The shaft leaves the casing through two holes, there being no attempt at fitting any kind of shaft seals, since the casing pressure is atmospheric, and condensing does not take place under vacuum.

The rotor is made of 0.005 in. thick half-hard shim brass with 30 blades, each blade being nearly 3/32 in. square before curving into proper form. The curving was done in a little die nearly half round, the brass being forced into it by a light tap on a suitable sized drill shank. Then the blades were twisted carefully at right-angles to the rotor itself. The rotor is mounted on a turned brass hub which is pressed on the shaft. There is no shroud fitted.

Rotor balance was made on a pair of parallels consisting of two razor blades mounted upright on a piece of glass—a porthole glass which, incidentally, makes the finest kind of lapping plate. This much is certain ; no model turbine will really perform until it has been perfectly balanced. I balanced mine till it would stand still on the razor blades at any position, when the glass was level. When the glass tilted slightly, the rotor would start to roll smoothly, however slight the incline. Naturally the entire rotor assembly, including shaft and pinion, was balanced as one, and the journals themselves were resting on the blade edges.

The "Works"

The nozzles and the blades are really the heart of a turbine. This one has three nozzles, each drilled No. 59. On non-condensing turbines running with steam over about 30 pounds, we need diverging exit passages in the nozzles, reamed out to a slight taper, say 6 or 7 deg. The inlet end needs to be given a nice rounded entrance. The best advice is to make the steam nozzles like the steam nozzles "L.B.S.C." describes for his injectors. Three nozzles were fitted to the model, with one uncontrolled or open all the time and two being provided as hand-controlled or "overload" nozzles. Some day a governor will be fitted on the turbine, and space is left for the governor valve in the steam nozzle block. The hand-controlled nozzles have little bodies turned down from $\frac{3}{16}$-in. brass rod, but they have no packing. The body screws right into the nozzle block, and the valve disc and stem are as one, being made from 1-72 bolts in fact, with the bolt being put in a high-speed drill press and the head lightly filed to about a 45° angle for the seat, and the hex head rim then being touched with the file to make it round. This valve screws into the body from beneath, there being no packing gland. Instead, a long thread in the valve body is relied upon to stop leakage of steam. It works. Tiny dummy hex glands are none the less turned and filed on the valve bodies, for appearance's sake. Little hand-wheels were turned from a knurled piece of $\frac{3}{16}$-in. rod by use of a hand tool, tapped 1-72, and screwed and soldered lightly to the stems.

The nozzle block is a bit of brass, filed to shape, drilled for steam chest passages, screwed $\frac{1}{8}$ in-40 for the valve bodies, spot-faced down inside for the valve seats, and then further drilled for attachment of the nozzle assemblies. Each nozzle is a tiny speck of brass made as described above, No. 59 bore, with about $1\frac{1}{2}$ threads size 2-56 left to screw them into $\frac{3}{16}$ in. diameter holders, which are themselves drilled for the steam and threaded 18-40 into the nozzle block. The three nozzles are mounted so as to blow against the blades at as slight an angle as will be reasonable ; it is about 20°. The rotor is set on the shaft to run as close to the nozzle tips as possible without fouling the nozzles.

It is important to reduce condensation where-ever possible and I believe that one fault with many model turbines is that the nozzle is built up integral with the casing at the point of attachment. Accordingly, the heat in the steam is lost to quite an extent because the casing is only at 212 deg. of atmospheric pressure steam, and this cools down the nozzle unduly. On this model there is a bit of Hallite between the nozzle block and the casing, and there are as few screws as possible—four—making contact with the casing proper. Thus the block has a measure of insulation from the bulky and cool casing.

Additions

As the photographs show it, the model is not yet completed. Later plans include an electric circulating pump with a motor about $\frac{3}{8}$ in. or, at most, $\frac{1}{2}$ in. in diameter, a lube oil piping system fed from two overhead tanks wherein we shoot a supply of very thin lathe spindle oil and allow it to seep through tiny hypodermic needle tubing to the rotor bearings and gearbox, from which most of it may be expected to fly off or leak out, yet oiling the gears and bearings just the same. Ladders and gratings as well as handrails are yet to come, and the model is to be painted as real engines are, probably dark red down around the tank tops and bilges, up to the first or lowermost grating, and then either white enamel or buff enamel above. The turbine has a blued steel band surrounding the casing.

Later plans also call for a regular throttle valve assembly, and an astern rotor for going astern. This isn't as complicated as it may sound ; the reason that it has no astern rotor now is to see what kind of performance are obtainable from the ahead rotor without the drag of an extra rotor.

Power tests are not fully made. It is hoped to measure horse-power and water rate, thermal efficiency and so on. This it will do, however. One can blow with the breath into the nozzle block and the rotor will do about 5,000 r.p.m. On 25 lb. pressure the turbine hits 50,000 easily, and owing to the great reduction in the gears, the turbine torque is multiplied probably over 40 times, depending on whatever the gear efficiency is. (It would be multiplied 50 times were there no friction in the gears.) Anyway, with two or three nozzles open, it is hard to stop the propeller shaft with thumb and forefinger. The shaft, turning at about 1,000 r.p.m., easily has enough power to turn the 3-in. propeller shown, were the job in a boat. The model is now "rated" at 50,000 turbine r.p.m., 1,000 shaft r.p.m., and it seems to do this without undue strain.

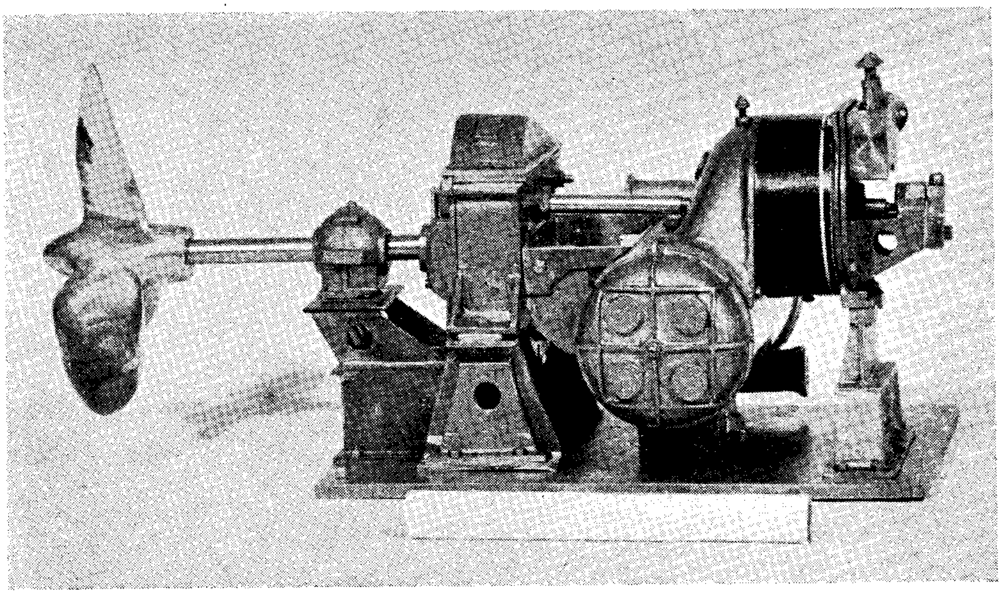
Actually, I have reached the limit in allowable speed with this little job, considering the tiny watchlike gears and the arduous work they now are doing compared to the gentle ticking duty they used to have. My highest speed was about 70,000 r.p.m. on 60 lb. pressure and three nozzles, but this was too much for the teeny spindles or

journals on the intermediate gear. One sheared off flush with the low-speed pinion, and, believe me, it was a job to make the repair, or rather the rebuild. I turned a cuplike affair of steel, pressed half the pinion in it, soldered it and fouled up three of the teeth with solder, picked the excess solder out with tiny tools, and finally got the stub extension running in a new bearing enlarged in the place of the old one in the frame.

My idea of an intriguing model steamer would be a freight ship or tanker with a unit like this installed in the engine room, and a realistic boiler installation to match, in about 5 ft. hull. Then we would get someting realistic in appearance down below, which would none the less drive the model at a decent speed. I believe it would be interesting to try *two* boilers in a model's fire-room or boiler-room, and equalise their water levels through, say, a $\frac{5}{16}$-in. connection between them, low down, with a smaller equaliser between the steam drums. Just as very small engines can be made to give out substantial power, so can little boilers, if they circulate freely, give out lots of steam. Good firing is essential. Some work is being done here in the U.S.A. by Mr. Neff, who makes "O" gauge locomotives burn liquefied gas same as some farm stoves do in burning Protane and similar gases. This would be good in marine models.

I plan some day to model the historic ship *Turbinia*, of Sir Charles Parsons. She will be built up of 0.005 in. shim brass, be about 4 ft. long, and have turbine drive and a replica of the original water-tube boiler. I am surprised that she has not been modeled more often before.

If I may, I should like to offer the suggestion that model makers try photographing their models with a pinhole camera. Such a camera has an infinite depth of focus, meaning for model men that you can put the camera just as close to the model as you please. You can take any camera and temporarily convert it to pinhole service by removing the lens and replacing it with a sheet of tinfoil, pierced with a fine needle in the centre.



A side view of the model turbine unit

Make a hole about 0.020 in. diameter. Use regular film and a 15 sec. time exposure in sunlight. You can get some astonishingly realistic close-ups this way. Their only trouble is that when all is said and done the image lacks the hair-line sharpness of a good lens picture, but it has much to recommend it just the same.

I wish to acknowledge articles in THE MODEL ENGINEER of May 23rd, 1946 by Mr. Walter Elkin and of August 29th, 1946 by Mr. A. E. Scott. Mr. Elkin showed that speeds over 100,000 r.p.m. are possible. I recommend small rotors, not much over 1 in. or so in diameter. Indeed, if smaller, there is no reason why absolutely phenomenal speeds cannot be reached, when it is remembered that the velocity of steam from even low-pressure nozzles runs up several thousand feet per second—2,000 to 3,000 or better, depending on the pressure drop.

A further report will be made on the power, steam consumption and efficiency of this small turbine at a later date when tests are completed.

RULES FOR MODEL TURBINES

Perfect balance.
Very high gear reduction ratios.
Carefully shaped impulse blades.
Correct convergent-divergent steam nozzles.

*A "Three-Cylinder" Electric Motor

by A. D. Stubbs

THE finishing ends of both coils are taken through the baseplate, soldered together and to a common earth return, as shown in Fig. 3, but before fixing each solenoid to the base by its 6-B.A. set-screws, protect the windings with a few layers of paper. I covered the whole with polished brass foil, the joint of which lies along the base. Two quick touches of the soldering iron fixed them, and if you adopt this method be careful not to heat up the winding under the foil.

Fig. 7 details the baseplate, mine being 16-gauge sheet brass. The drilling of all the holes is straightforward, also the three $1\frac{3}{4}$ in. × 1 in. rectangles, which are cut clean away. The $1\frac{1}{2}$ in. × $\frac{7}{8}$ in. rectangle is cut on the full lines, and the two bearing plates for the control levers are bent 90 deg. upwards on the dotted lines.

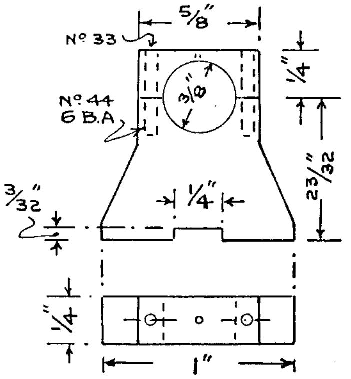


Fig. 8

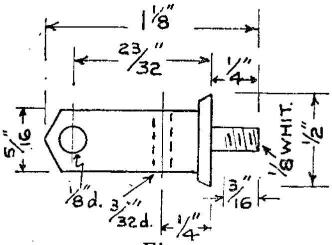


Fig. 9

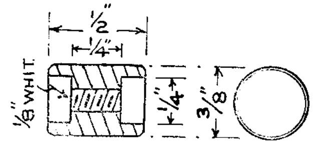


Fig. 11

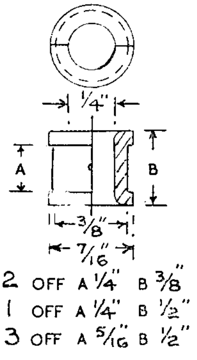


Fig. 10

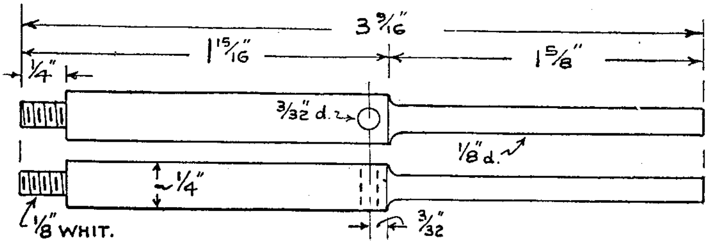


Fig. 12

The three crankshaft bearing blocks stand on the hatched rectangles, 1 in. × $\frac{1}{4}$ in. These are not cut out; in fact, I did not drill them for holding screws, but soldered the blocks to the base. In the centre of the base of each block, Fig. 8, I cut a $\frac{1}{4}$ in. × 3/32 in. recess. This served for the temporary insertion of double wedges, which I used for accuracy in levelling. This became necessary because the commercial 16-gauge brass, after having the four rectangles cut away, bore little resemblance to a surface plate. I built up a good tinning of solder on the block, then a bunsen flame soon settled things exactly. It was also necessary to add a stiffening piece of $\frac{1}{2}$ in. × $\frac{1}{16}$ in. brass strip across the baseplate, on edge, alongside the holes securing the piston-rod guides, Fig. 9, before I could get them in line. The baseplate is itself wood-screwed to four pieces of teak, $\frac{3}{4}$ in. × $\frac{3}{8}$ in., all corners being dovetailed.

My bearing blocks, Fig. 8, are cast brass,

**Continued from page* 439, "*M.E.*," *April* 5, 1951.

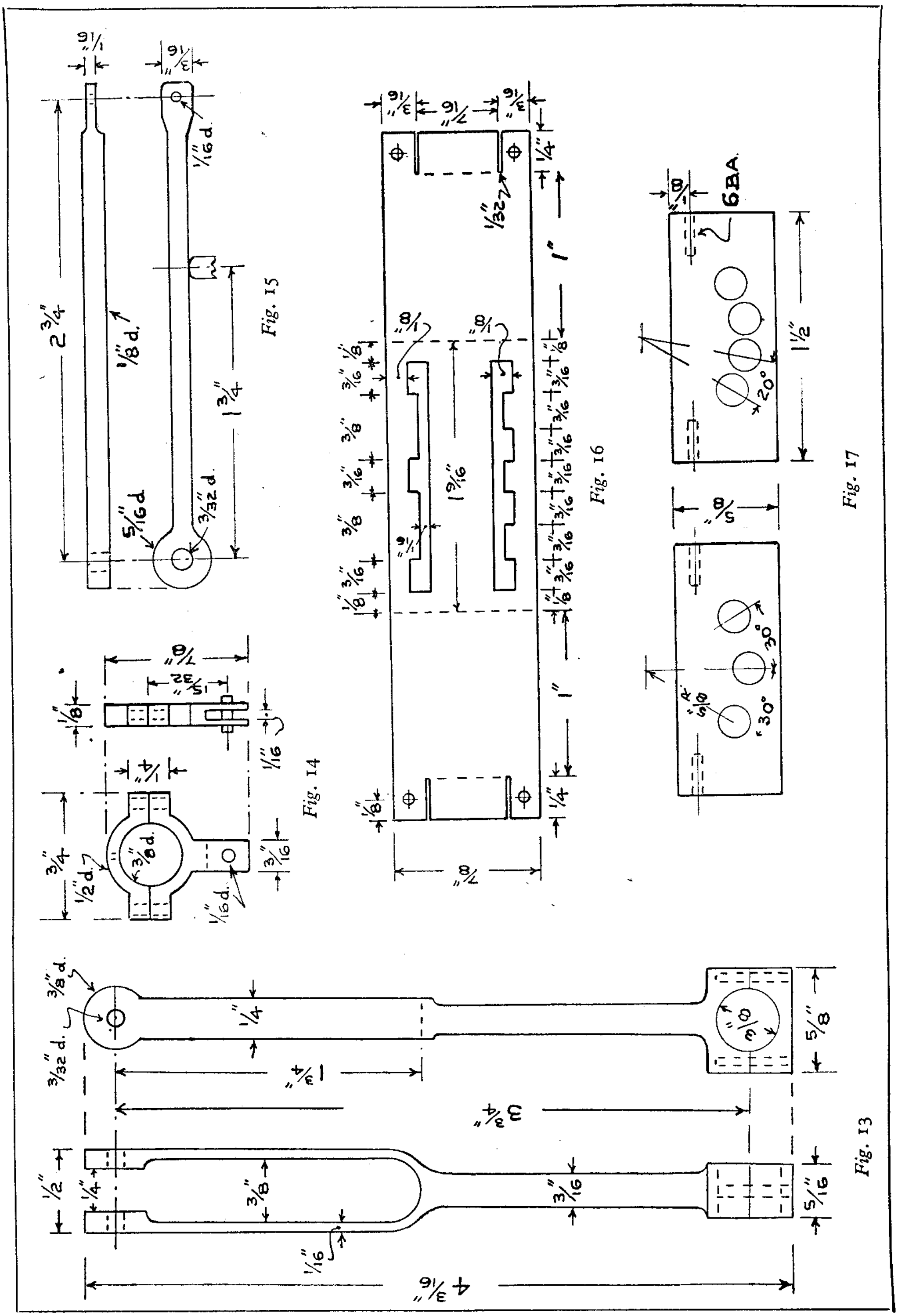


Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17

machined all over, so there was really no necessity to have separate brasses, Fig. 10, but I just felt that way. It would save a lot of time to have a boss cast to produce the ½ in. "B" dimension.

Fig. 9 shows the piston-rod guides. Two only are cross-drilled 3/32 in., these carrying the eccentric connecting-rod axis pin. Material, brass rod.

For the three pistons, Fig. 11, I used steel. Cast-iron would be better, but I could not locate any. However, the steel works all right, although the steel piston-rods, Fig. 12, were rather tricky, because the reduced ⅛ in. diameter had to be dead true. If I built another I should use ⅛ in. silver-steel, and braze on a bush, to be later drilled for the crosshead pin. The pin itself I have not detailed. It is 3/32 in. diameter brass rod, 9/16 in. long, lightly riveted at each end after final assembly.

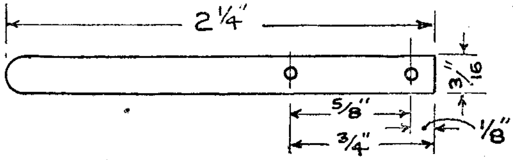


Fig. 18

The connecting-rods, Fig. 13, bear an unlucky number, and they certainly gave me a fair share of work. From the big-end to the fork, ¼-in. steel was used, upset to just over the big-end dimensions, and ¼ in. × ⅛ in. steel strip was bent to shape and brazed to the ¼ in. round, the small-ends being forged up to give the ⅜ in. diameter. All this meant that I had to machine the rods practically all over, including milling the forks down to 1/16 in. but they look nice. The big-end set-screw holes are drilled No. 33 in the caps, and No. 44 in the body, the latter tapped 6 B.A.

By comparison, the three eccentric saddles, Fig. 14, just rolled off the lathe bed. These were cut from ⅛-in. brass sheet, with a spot of hand-filing thrown in. Set-screw holes as for the connecting-rods.

In Fig. 1 the three eccentric connecting-rods are visible, Fig. 15, giving the detail. For these I used ⅛-in. silver-steel, and the eye ends were just bent around to butt, and not shut welded, but drilled 3/32 in. for the pivot-rod.

Part of one switch tappet pin is shown in this sketch, whilst Fig. 2 gives detail of the application. Each pin is ⅞ in. × ⅛ in. diameter, from silver-steel, and to secure the lower end I cut up a bicycle brake block. This encircles the switch arms, and the pin sits tight in a 3/32 in. hole in the top.

My slitting saw came into its own in the production of the control-lever stand, Fig. 16. This is brass sheet, 20-gauge, cut on all full lines, and bent on the broken lines. Fig. 1 indicates the general shape, the two turned-up ends being soldered to the under side of the baseplate.

Both the control plates, Fig. 17, are from 3/16-in. ebonite sheet, once part of a radio set. The four and three, respectively, ⅜ in. circles indicate brass contact screws. They started off in life as ¼ in. brass countersunk set-screws, and the surplus ends, after nutting, were cut off. These plates are, of course, set-screwed vertically to the control-lever stand.

To produce the levers, Fig. 18, I used ebonite again, and in each foot hole a contact screw is required. Brass bar, ⅜ in. diameter is ideal, left full diameter for 1/16 in. depth to contact the plate screws, with a shank screwed 6 B.A. and nutted.

When the levers are assembled, their two contact screws were electrically wired together with a piece of the 28-gauge instrument wire, wound around a length of 1/16 in. wire, later withdrawn, to form a spiral, this giving complete flexibility.

Between the levers, and slipped over the 1/16-in. axle upon which they move, is a fairly strong expansion spring. I located one from a mixed box of Terry's at a cycle shop.

You will notice that in giving "hole" and "shaft" dimensions I have, in most cases, used the same nominal size. Clearances are, of course, necessary, and this can most readily be achieved by using numbered drills.

Yes, it meant a lot of work, but the sparkle in one small boy's eyes when he got going on the two levers well repaid the trouble and, anyway, I enjoyed it.

For the Bookshelf

Danger Ahead, by Richard Blythe. (London: Newman Neame Ltd.) 132 pages, size 5½ in. by 8½ in. Illustrated. Price 10s. 6d.

This is an entertaining book which sets out the dramatic story of railway signalling from the earliest times until the present. It is obviously not designed to appeal primarily to the technical expert, but is intended to be of interest to the general reader as well. Many anecdotes, humorous and otherwise, are interspersed in the history of the development of the most important safety device for the protection of railway travellers.

There is an informative introduction by Mr. T. S. Lascelles, Director and General Manager of W. R. Sykes Interlocking Signal Co. Ltd., who stresses the importance of the work of Edward Tyer for some 30 years, in inventing and introducing most of the electrical devices, modern improvements of which are so familiar to us today.

The 40 illustrations are made up of drawings, five of them in colour, by Dick Hart; we find them pictorially representative rather than technically accurate.

PETROL ENGINE TOPICS

*A 50 c.c. Auxiliary Engine

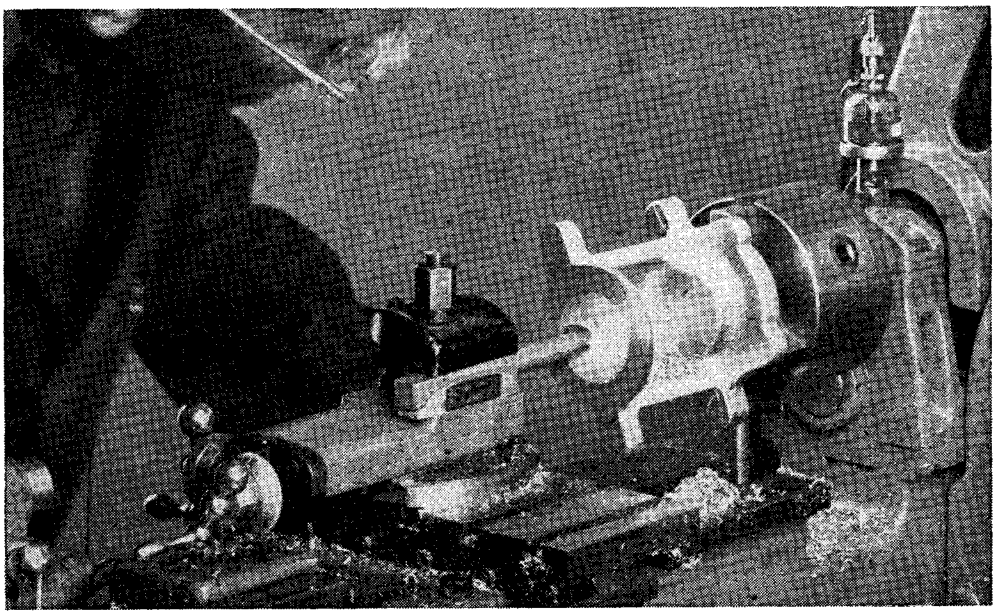
by Edgar T. Westbury

THE most important structural component of this engine is the main housing, and the machining of this casting may well be taken in hand first, though there is no rigid order of precedence in this respect. It will be seen that the two ends of the casting are bored in axial and concentric alignment to take the inner crankshaft ball-race and the outer-end spigot plate or housing, which in its turn carries a second ball-race. The alignment of the two races is obviously of the highest importance, as any error in this respect would cause them to bind, and though this trouble could be side-tracked by using self-aligning races, it would involve the equally serious trouble of binding in the packing bush.

There are several ways of machining the casting so as to ensure alignment of the two ends; a fairly obvious method would be to machine the inner-end first, including the two diameters for the ball-race recess and the bush seating, and then locate from these bores by mounting the casting on a stepped spigot mandrel held in the four-jaw chuck, for dealing with the outer-end. While this is fully practicable, however, it entails the necessity for turning up a large piece of material, which possibly may not be readily available in the small workshop, especially in these days of scarcity.

The method actually adopted was simpler in respect of preliminary preparation, and equally effective. As will be seen from the photograph, the casting was first held in the chuck, with the outer-end projecting, and set up so that the circular portion of the outside surface ran fairly true. The cored hole should not be taken as the reference surface, as it is always possible that the core may not have been placed exactly central when the casting was made. As I have often pointed out in articles on machining, castings should always be set up by reference to the surfaces which will finally be left unmachined, unless other surfaces are so badly out that they will not clean up to finished size, when some compromise must be made; this state of affairs, however, should not arise with good castings.

Provided that the surface of the inner-end spigot is reasonably clean, it is quite in order to hold the casting, by this surface, in the three-jaw chuck, as the work to be done on the outer-end



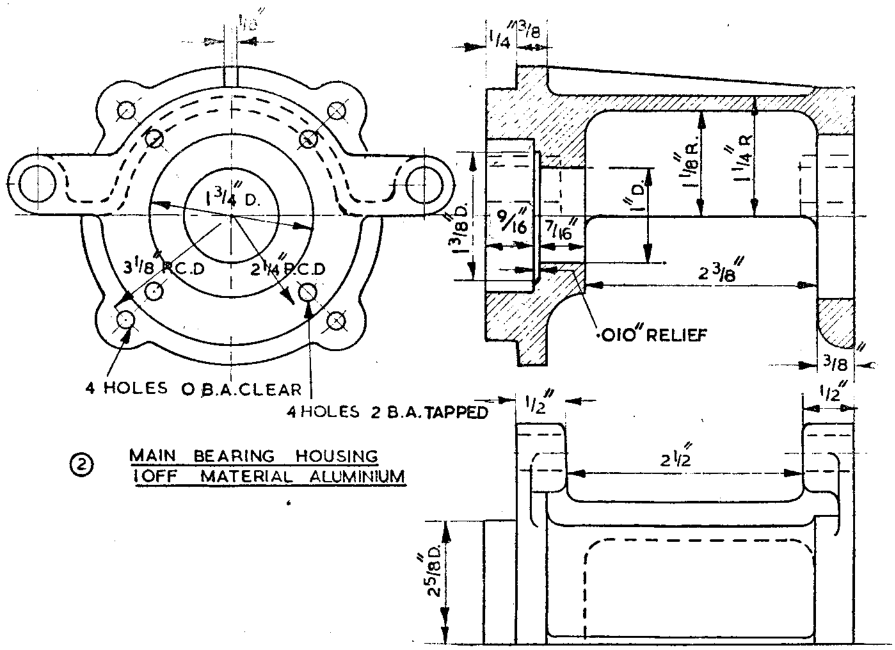
The first operation on main housing : facing and bor ng the outer-end

*Continued from page 418, "M.E.," March 29, 1951.

is quite light. If bumps or flashes exist on the casting, they may be filed off before setting up ; no marking-out of the casting should be necessary before main machining operations, but a rough check-up to guard against major inaccuracies is desirable.

need not necessarily be dead true, if the disc is machined after mounting, and is not shifted before the casting is located on it. Two light clamps, over the lugs of the casting, will then secure the latter firmly against the faceplate.

Machining of the inner-end, including the



② MAIN BEARING HOUSING
1 OFF MATERIAL ALUMINIUM

The outer-end face of the casting is then faced off, and the hole bored ; in neither case is critical accuracy of dimensions important, as there is no positive end location of the outer bearing, and, the spigot of its housing can be fitted to the bore, but it is obviously desirable to work as closely as possible to the given sizes. What is important is that the bore should be truly circular and the face flat, and at right-angles to it, both of which conditions should be automatically ensured by careful machining.

In the second operation, both these surfaces are used as reference faces to ensure that concentric and axial alignments are positively assured. The casting, as seen in the next photograph, is clamped to the faceplate, which, assuming the latter runs truly (and if it does not, it should be corrected before any attempt is made to carry out accurate work !) will provide true axial alignment ; its bore is located by means of a spigot or " bung " to take care of concentricity.

The locating spigot consists of a disc, which need not be of any great thickness, secured to the centre of the faceplate in any convenient way. In the example illustrated, I pressed a disc of light alloy on the parallel end of the Myford hollow centre, and after inserting the latter in the mandrel socket, machined the outside of the disc *in situ* to a push fit in the bore of the casting. Any old centre, or the shank of a broken Morse taper drill, may be used to carry the disc, and it

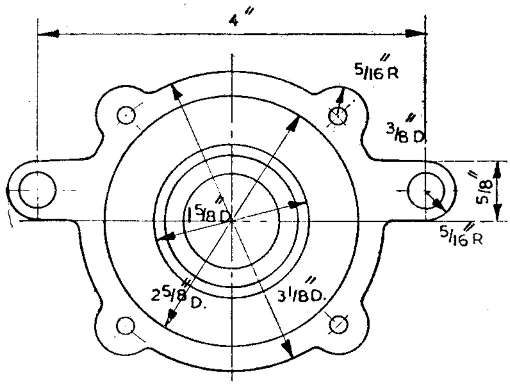
spigot and the two diameters of the bore, is quite straightforward, but in the latter operations, exact sizes must be observed. The ball-bearing manufacturers specify that the outer race should be a neat push fit, but in my experience, a somewhat tighter fit is desirable in a light alloy housing, owing to the fact that the machined surface tends to hammer or burnish down slightly in the early stages of running, and the race is liable to become slack. It is not easy to fit a ball-race by " feel," as its axial alignment cannot be ensured, and I recommend making a temporary plug gauge, which may consist of a disc of metal held on a mandrel or bolt, and machined on the outside to about 0.001 in. smaller than the diameter of the race. When this will slide into the bore without shake, the fit of the race is about correct. I do not approve of boring housings slightly undersize, and fitting the races by hand scraping, as this may introduce inaccuracy, however carefully it is carried out.

The bore of the bush seating may have to be related to the diameter of a ready-made bush, and the amount of interference recommended by the makers should be observed. In the machining of the housing spigot and flange face, exact dimensions are less important, but it is desirable to finish these before the boring operations, so that the depth of the ball-race housing can be gauged. Do not forget to relieve the face of this recess so that the inner race does not foul ;

only a few thousandths of an inch are necessary, and the relief should extend outwards to about the inner diameter of the outer race.

End-location of Ball-race

I have never found it necessary to clamp or otherwise end-locate ball-races in my engines, provided that they are properly fitted, and the

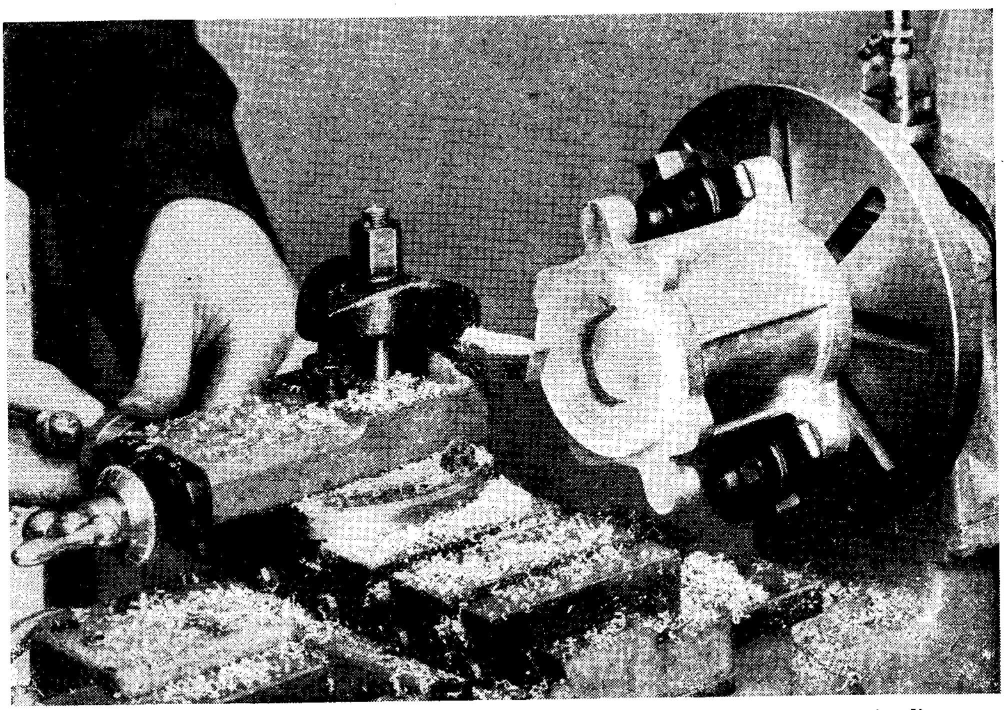


Inner-end face view of main housing

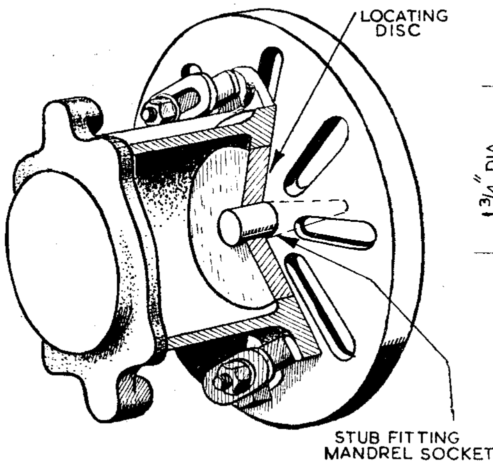
shaft is prevented moving endwise, but if constructors wish to add some provision of this nature it is quite possible to do so. The simplest form of locating device is a circlip, preferably of the Seager (pressed steel) type, rather than a plain steel wire ring ; a groove to take this may be machined in the recess, immediately in front of the ball-race. If it is desired to clamp the race, a retaining flange, with an inner projecting lip, may be fitted to a suitable recess machined in the front face of the housing, and secured in place with four or more countersunk screws.

While the casting is still in the lathe, the positions of the stud holes in the flange may be marked out with the aid of an indexing device on the lathe mandrel, or better still, "spotted" by means of a drill spindle on the lathe cross-slide. To mark out the holes in the bearer lugs, a centre-line should first be struck horizontally with a scribing block on the lathe bed, across the end faces of the spigot and flange ; the scriber point is then raised $\frac{5}{16}$ in. and another line scribed across the face of the lugs, then produced on their ends, and extended to the other pair of lugs as well. The casting may then be reversed and held in the three-jaw chuck, a check being made to see that it is not perceptibly out of truth ; the centre-line of the lugs can then be picked up with the scriber and produced across the other end face. A point tool held in the tool post may be used to mark the radial position of the holes, which are 4 in. apart, but as they do not lie on the diametral centre of the flange, that is not the same thing as 2 in. radius.

Unless one has a fairly large drilling machine —and not always then—I do not recommend attempting to drill the holes in the lugs directly to full size at one operation. It is better to drill small pilot holes, not more than $\frac{1}{8}$ in. diameter,

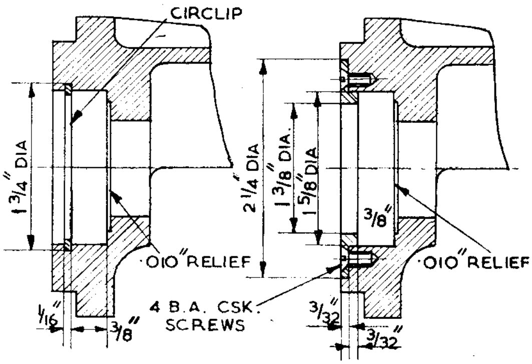


Main housing reversed and mounted on faceplate, with locating plug to ensure concentric alignment



How the main housing is located to ensure concentric alignment of bearings

from both end faces, and open them out afterwards. As the accuracy of the holes is of some importance, it is advisable to finish them with a



Methods of end-locating the inner ball-race, by the use of either a circlip or a retaining plate

reamer. The inner faces of the lugs may be spot-faced, if a suitable cutter is available, or skimmed with a lathe tool while the casting is set up for the main operations.

(*To be continued*)

Models at the Packaging Exhibition

by F. J. Christall

THE use of models of various kinds as part of the exhibits at the recent Packaging Exhibition shows an increasing interest by firms wishing to make their exhibits more attractive and instructive.

Further, a well-made model is far more impressive than a photograph.

The biggest exhibit, and perhaps the one to attract most attention, was the *Van Leer Mobile Drum Factory* (full size) in which a complete steel drum, from the sheet steel to the finished enamelled drum, was made on lorries parked together to form a factory.

A model of the firm's factory at Ellesmere Port to a scale of 1 to 150 included a most attractive reproduction of an 0-4-0 saddle tank, *Stanlow*, with trucks and vans.

There was also a larger model of one bay of this factory, showing working models of some of the plant, and at one end another model of *Stanlow*, this time to a scale of $\frac{3}{8}$ in. to 1 ft., and some covered vans.

The Johannesburg factory was also shown in model form with 3 ft. 6 in. gauge flat cars and box cars (bogie) of the South African Railways.

Another exhibit was of over 100 models of motor-cars, vans, trailers, etc., from the study of which the mobile factory was designed.

In the rest of the exhibition, in the main hall, the following were noticed :—

Printing, Packaging and Allied Trades Research Association.—Model of testing plant for various forms of packages, including " Impact," " Crush," and " Vibration " tests, etc. ; this was a working model about 3 ft. × 2 ft.

Parcels and General Assurance Association.—Leeds Model Company's 0-4-0 (smoke effect) tank and goods train on large oval, which must have covered a few miles during the course of the exhibition. Also on this stand were waterline models of cargo and passenger steamers and aircraft.

Export Packaging Service Ltd.—Factory, docks, waterline ship models, warehouse with sidings and Trackmaster trucks and vans.

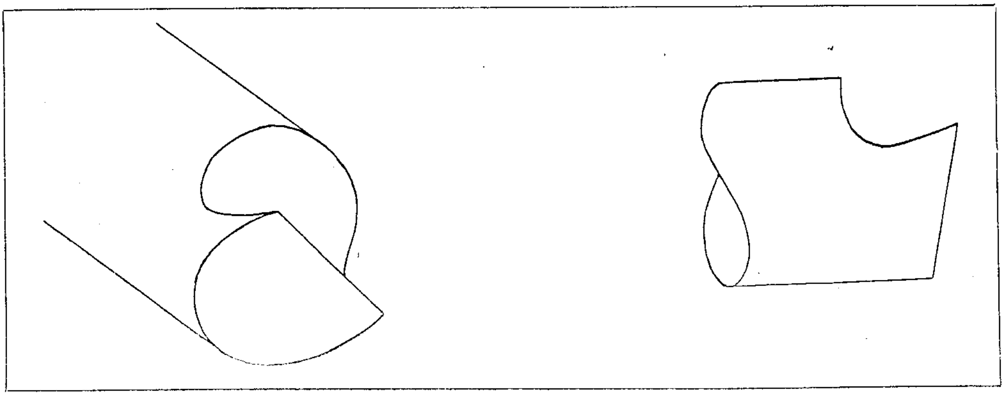
Alite Filling Machines Ltd.—A 1 in. to 1 ft. model of a powder filling machine, forming the centre part of the decoration of the back of the stand.

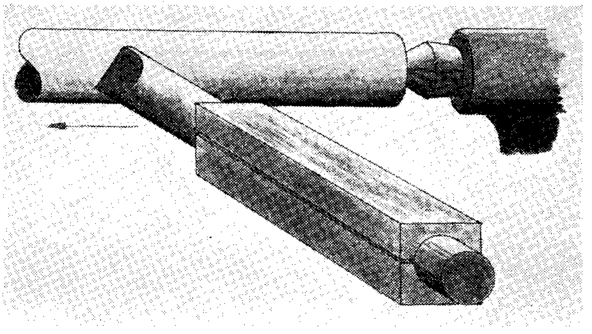
Van Leer Mobile Factory.—Scenic model with a road climbing a hill (hairpin bend) and crossing itself on a girder bridge. At intervals along the road were models of the various vehicles used in the mobile factory—trailers, vans, cars, etc.

No doubt at future exhibitions a still larger number of models will be used to the interest of model makers and customer alike.

A Turning Tool for Fine Finish

by L. A. Watson





THE enlarged sketches reproduced herewith are of the tool I use to obtain an extra fine finish on shafts, etc., especially when the surface is subsequently to be lapped.

Having an "Eclipse" H.S. boring tool with a long shank otherwise doing nothing, I ground the tool point on the blank end to the shape shown. Four or five degrees of front clearance is all that is necessary with about eight degrees of top rake. It is essential that the cutting edge is ground at right-angles to the shank and the tool clamped at right-angles to the lathe centres. The cutting edge is presented to the work at an angle of about 45 degrees to the vertical, but if a greater angle is employed, there is a risk of chatter owing to the comparatively wide edge in contact with the work.

I have a number of square M.S. holders for circular shank tools, so the adjustment of the cutting edge relative to the work is a simple matter. It is advisable to oilstone the cutting edge.

It will be appreciated that if the initial grinding to shape is carefully done, the tool will always cut at lathe centre height regardless of whether the axis of the shank is above or below lathe centre height; the value of this will at once be apparent when finishing outside tapers.

The tool should not remove more than 0.001 in. at each cut, as it is essentially a finishing tool; if there is any tendency to chatter, this can be cured by bringing the cutting edge more to the vertical.

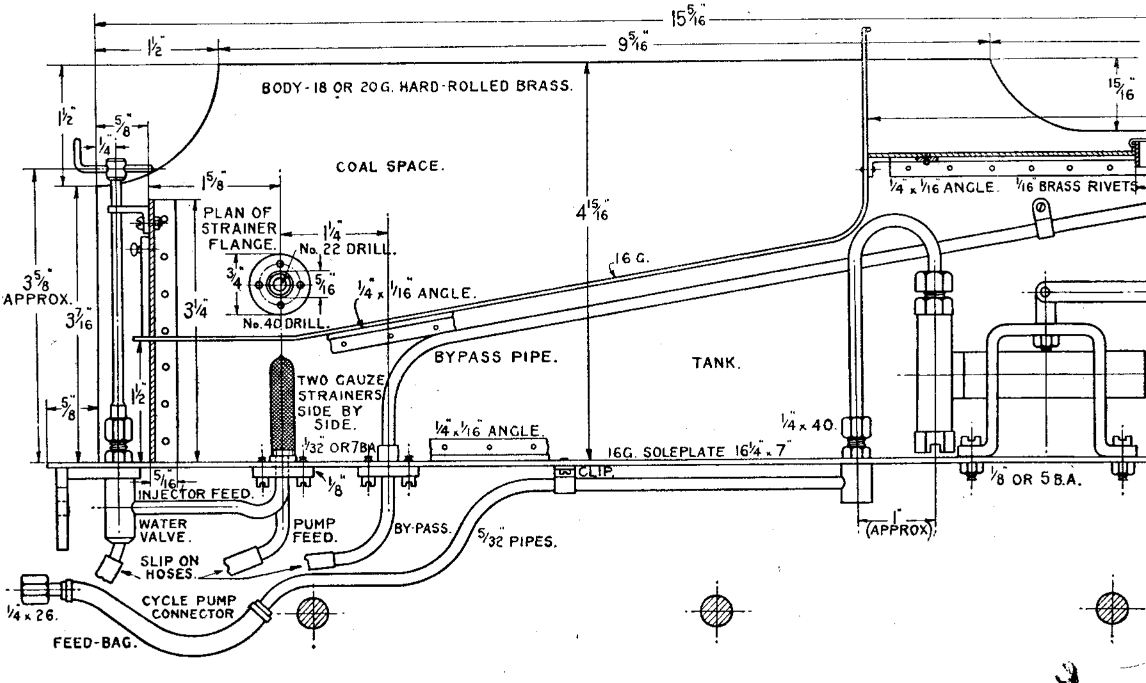
In the wash drawing reproduced, the tool-clamping arrangements are omitted for the sake of clarity and the tool itself is shown projecting rather more than it would be from its holder, also for the sake of clearness.

I made my original drawings large partly to show the shape of the tool point, as it will be realised that a $\frac{3}{8}$-in. diameter shank does not carry a very large point, and a photograph is not entirely satisfactory.

"PAMELA"

A $3\frac{1}{2}$-in. Gauge Rebuild of a

APPROVED advertisers who have supplied castings and material for the locomotives described in these notes, have hitherto been able to furnish the set of tender axleboxes cast in a stick; but whether they will still be able to do so, in view of the restrictions in force at time of writing, is something I don't know. A total ban on the manufacture of implements of bloodshed and destruction, by every country in the wide world, would be far more sensible, in your humble servant's opinion! However, if castings are available, mill the grooves before parting the boxes, by the method described for the engine axleboxes; and if the stick is too long for your cross-slide, cut it in half and take two "bites." Either part the boxes in the four-jaw, or saw them off, and then chuck each separately, and face the ends. Axle holes and oil holes are drilled the journals can be oiled direct, same as on a full-sized engine. When erected, the axleboxes are prevented from dropping out, when the tender is lifted, by hornstays made of $1\frac{3}{8}$ in. lengths of $\frac{3}{16}$ in. $\times$ $\frac{1}{16}$ in. strip steel, attached by small screws, 9-B.A. or whatever you happen to have handy. The plan view in the last instalment shows how the boxes should fit the horns.



Section of tender body

as shown in the section. Note, the boxes should be fairly easy, though not slack, in the horns, and should be able to tilt a wee bit. Cast axleboxes will have the ornamental fronts cast on; clean up with a file if there is any roughness.

Should castings not be available, bar material can be used, of $\frac{3}{4}$ in. $\times$ $\frac{7}{8}$ in. section, or nearest larger, the machining being exactly as indicated above. The ornamental fronts, which are, of course, the lids in the full-sized articles, can be made from $\frac{1}{16}$-in. brass sheet, with a piece of strip soldered on to form the locking bar. They can be attached by a couple of small screws; or if you want a touch of realism, attach by a single screw near the top, so that they can swing aside. If the axleboxes are drilled right through,

The illustration of the cast dummy type of spring, is self-explanatory. The hoop, or buckle, is drilled to take a hollow buffer-plunger containing a spiral spring which presses it down on the axlebox, as shown in the section. Drill a No. 40 hole at each end of the spring, to accommodate the spring hanger pins. These are made from $1\frac{1}{4}$-in. lengths of 13-g. spoke-wire, or 3/32-in. silver-steel. Both ends are threaded 3/32-in. of 7 B.A. Chuck a bit of $\frac{1}{4}$-in. round steel rod in the three-jaw; face, centre, drill No. 48, and part off twelve $\frac{1}{8}$ in. lengths. Tap each, to suit the thread on the pins; screw on tightly on top of each pin. Chuck the pin in the three-jaw, and turn the head to the shape shown. The lugs into which the pins are screwed,

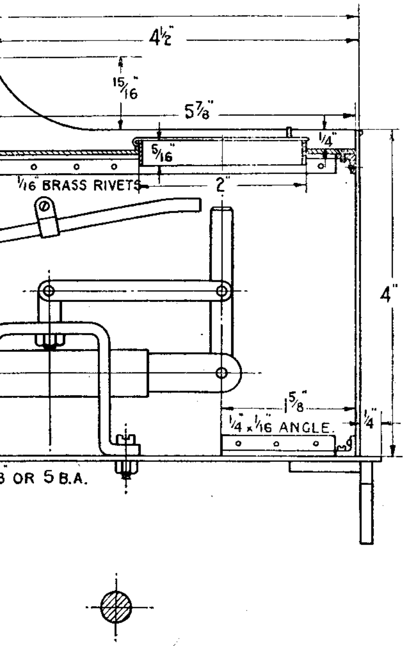
by "L.B.S.C."

…build of a Southern Pacific

were described in the last instalment, along with the frames.

To erect the springs, all that is necessary, is to put a pin through the hole at each end of the spring, and put the spring in place, the plunger projecting $\frac{3}{16}$ in. below the hoop, and the spring slightly compressed. Screw the lower ends of the pins through the lugs, and secure with a commercial nut under each. Adjust the pins so that all three springs on each side are level; and have both sides the same, so that the tender won't lop over to one side when on the rails.

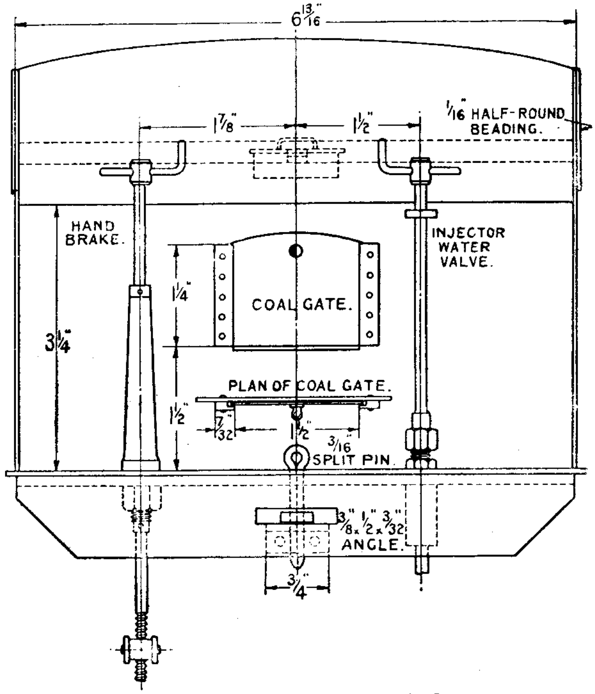
Working leaf springs take very little longer to make, and are quite flexible if made *a la* Tom Glazebrook, each leaf being made from three thicknesses of thin spring steel. The hoops for these are shown in the illustration, and are turned from $\frac{1}{2}$ in. square steel, held in four-jaw. The rectangular hole is formed by drilling and filing. A setscrew, preferably of Allen type, in the boss, holds the nest of leaves in place; and the complete spring is erected in exactly the same manner as described above for cast dummies. They are very realistic when in action.



Tender Body

Hard-rolled brass of 18 or 20 gauge is the best stuff to use for the tender body; but if not available, just use whatever you can get. Galvanised or leaded iron is a good substitute. Ordinary steel rusts quickly, but a few coats of aluminium paint inside the tank might teach it good manners. Sheet aluminium is not suitable, owing to the fact that as it cannot be easily soldered, the joints couldn't be made tight.

A piece of 16-gauge metal is needed for the soleplate; this should measure $16\frac{1}{4}$ in. long and 7 in. wide. It is attached to the tops of the drag- and buffer-beams, and the side angles, by 3/32-in. or 7-B.A. brass screws, any kind of head, put through clearing holes and nutted underneath, rendering the body detachable from the frame. If the sides and back of the body cannot be made in one piece, make them in two, with a butt joint in the middle of the back. The actual joint is made with a butt-strip inside, riveted and soldered; and if the crack is filled with solder and smoothed off, it is invisible when the body is painted.

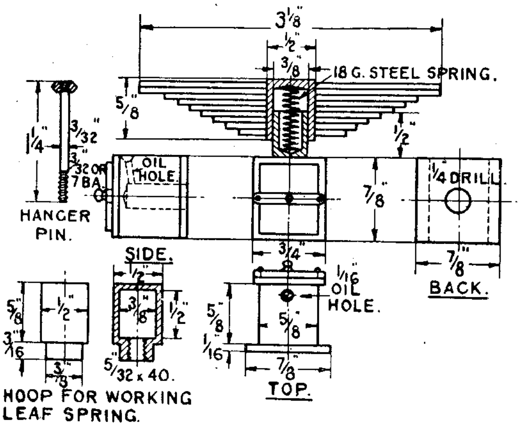


Front end view of tender body

Before attaching the body to the soleplate, fit the front of the tank, and all the angles. The front plate is $3\frac{1}{4}$ in. high, and $\frac{5}{16}$ in. of each end is bent over at right-angles for attachment to the body; this saves fitting two extra bits of angle. Cut out the coal gate opening, and rivet a runner at each side, to take the slide. Runners are made as described for those on the cab roof. The front plate is then placed in position, $\frac{5}{8}$ in. from the front ends of the body, and attached by

$\frac{1}{16}$-in. rivets, countersunk outside. Be sure to get the plate square across the body.

To make a really sound job, pieces of angle should be riveted the full length of the body, along the bottom edges of the sheets, also along the back, and along the bottom of the front plate, using $\frac{1}{16}$-in. rivets and spacing them about $\frac{1}{2}$ in. apart. I prefer a smooth-sided tender, same as we had on the L.B. & S.C.R. engines ; apart from the appearance, the cleaner boys found them very easy to wipe down. However, some folk prefer to see thousands of rivet-heads sticking out all over the sides and back of a tender—good luck to them, anyway ; different folk, different fancies—but it always seems to me as though the tender has grown pimples, or



Spring and axlebox details

developed a rash ! If you happen to be an admirer of rivet-heads, go right ahead and space them closely ; but for the love of Pete, keep the lines of rivets straight and even, and don't make their noddles too big. Remember that $\frac{1}{16}$ in. in *Pamela* equals 1 in. in her big sisters, and outsize rivets are not used in platework ; a nod is as good as a wink to a blind horse, as I've remarked before !

Two pieces of $\frac{1}{4}$ in. $\times$ $\frac{1}{16}$ in. angle, each $5\frac{7}{8}$ in. long, are riveted at $\frac{1}{4}$ in. from the top, at the back end of the body, and another piece right across the back, to carry the removable part of the tank cover. Two more pieces are riveted along each side, on the slant, to carry the sloping part of the tank cover, which forms the bottom of the coal space. Tip for beginners : to get both sides dead level, and at exactly the same inclination, in two wags of a dog's tail, cut a bit of cardboard a little smaller than the tender side, mark the lines showing the slope on it (which you can get from the drawing) cut it along the slope, put it inside the body at each side, and run your scriber along the sloping edge. If you set your pieces of angle at each side, to the lines marked by the scriber, they must of necessity be level. It doesn't matter about riveting bits of angle at each side of the coal gate opening ; the lip forming the shovelling plate projects through, and provides all the support needed.

Having fitted all the angles, drill a few No. 40 holes at about $1\frac{1}{2}$ in. centres, through the angles around the bottom ; then set the body very carefully in position on the soleplate. When O.K., tack it in three or four places with solder ; just rough blobs will do, as long as they hold. Then screw the body down to the soleplate with 3/32-in. or 7-B.A. brass screws, round or cheese-head, put through the clearing holes in the angles, into tapped holes in the soleplate. Another tip : use a No. 40 drill (broken bit does fine) stuck in a piece of $\frac{3}{16}$ in. round rod long enough to reach above the side of the tender body, to make the countersinks on the soleplate. A bit of No. 48 drill, mounted same way, will drill the tapping holes ; and for the actual tapping, get a short length of $\frac{3}{16}$-in. tube, or whatever size will go tightly over the square of the tap. Hammer this down tightly on to the square, so that the tap cannot turn in the tube ; put your tapwrench on the other end, and the job is a cakewalk. Don't forget a spot of cutting oil on the tap, which makes it go through easily, leaving clean threads.

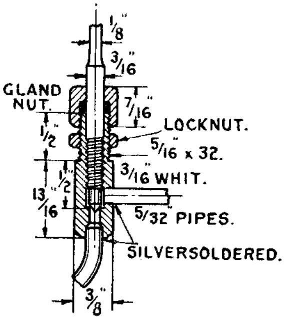
When all the screws are in, sweat all around the bottom, using a good big soldering iron, which holds the heat well, and plenty of liquid flux. Don't use a paste flux, for reasons stated when the boiler job was described. Cover the whole of the bottom angle, all the way around, paying particular attention to where the vertical part of the angle butts up against the side sheets. Go all over the screwheads, including those belonging to the screws attaching the soleplate to the frame. When through, be careful to wash out all traces of the soldering flux ; if any is left inside, there will soon be a light green deposit forming on the sides and bottom of the tank, and when it gets into the pump, injector, and clacks, it will play Old Harry. Prevention is better than cure !

Internal Fittings

The blobs and gadgets inside the tank are easily fitted whilst there is no cover on it, so make that the next job. As they are exactly the same as described not so long ago, for *Doris's* tender, there is hardly any need to repeat the full ritual ; a brief resume should suffice. The whole bag of tricks is shown in the sectional illustration. Both gauze strainers and by-pass pipe are fitted to $\frac{3}{4}$-in. circular flanges turned from rod. Leave $\frac{5}{16}$-in. bosses on top ; two of them have shouldered ends for accommodation of the gauze fingers, which are soldered on. The third is drilled right through with No. 23 drill, to take the top and bottom pipe connections, as shown. The other two are also drilled No. 23, but only have pipes at the bottom. All pipes are silver-soldered in. The $\frac{5}{16}$-in. holes for the strainers should be drilled about $\frac{3}{4}$ in. each side of centre line, at the position indicated in the section, and the hole for the by-pass fitting about $1\frac{1}{4}$ in. from centre, on the right-hand side.

The injector water valve is made in a manner somewhat similar to the screw-down valves on the backhead ; a section is shown here, and all dimensions are given in the drawing. Don't forget to put the upper bracket on the spindle

before fitting the boss and the cross-handle, as it won't go on otherwise! The long neck of the valve passes through a $\frac{5}{16}$-in. hole drilled through the top of the drag beam, and a lock-nut keeps it there. Make up the valve, connecting pipe, and strainer as one unit, same as for *Doris*; poke the valve through the hole in beam, from underneath, and the strainer through the hole in the soleplate, at same time. The strainer flange is held to the soleplate with three or four 3/32-in. or 7-B.A. brass screws; the others are similarly fixed. Put gaskets of 1/64 in. Hallite, or similar jointing, between flanges and soleplate.

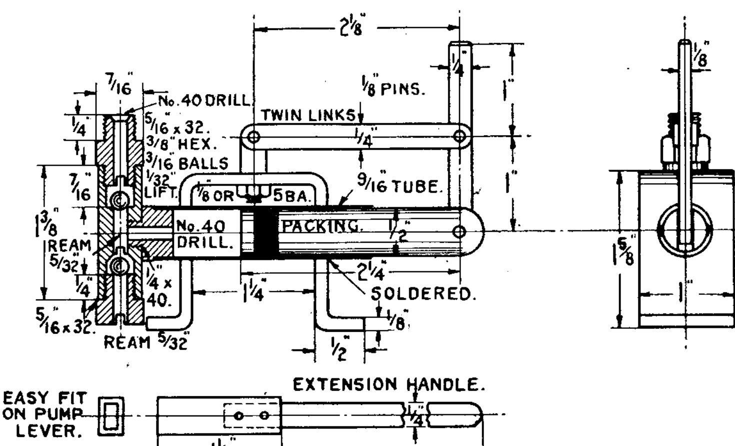


Injector water valve

down the middle (No. 40 drill) and a $7\frac{1}{2}$-in. length of 5/32-in. pipe silver-soldered into it. The $\frac{1}{4}$-in. hole in the soleplate, for the screwed part of the union, is approximately 1 in. ahead of the pump valve-box centre; but the exact position doesn't matter. After erecting, put a little clip on the pipe, just behind the bend, to prevent it flopping about when the engine is running. A similar clip is needed on the by-pass pipe, to keep the end in sight through the filler hole. Clip to side of tank, and bend pipe to suit. If a countersunk brass screw is used, nutted inside tank, there won't be any protuberance outside. The flexible hand-pump connection, known to enginemen as a feed-bag, is just the middle part of an ordinary cycle-pump connector, furnished with a $\frac{1}{4}$ in. × 26 union nut and cone. Ordinary rubber tube will do for the slip-on hoses.

Tank Top

This is simple plate work. The fixed part, forming the bottom of the coal space, needs a piece of 16-gauge sheet, $11\frac{1}{2}$ in. long, and wide enough to fit nicely between the tender sides. Cut away enough at each side of front end, to form a tongue which fits the bottom of the coal gate opening, forming the fireman's shovelling plate. Bend to shape shown, put temporarily in place, well down on the sloping angles, and mark where the side angles near the top meet the plate, draw a line across, remove plate, rivet a piece of $\frac{1}{4}$ in. × $\frac{1}{16}$ in. angle across it, to support the front end of the removable part of tank top, then replace, screw down to angles with any small brass screws you may have handy, and sweat all around with solder, not forgetting the crack under the shovelling plate. The removable part is merely a rectangular plate of metal, cut to fit the open top, and attached to the angles at sides, front, and back, by small brass screws; a filler, with hinged lid, is fitted as shown, being soldered into a hole cut to suit, in the plate.



Details of tender hand pump

The emergency hand pump is shown in section; and as it is of my oft-described "standard" type, no detailed description is necessary here. Beginners should look up the full instructions in the *Tich* notes. It is erected so that when the operating lever is vertical, centre of same is $1\frac{5}{8}$ in. from back of tender. It is connected by a swan-neck of 5/32-in. pipe, to an elbow union as shown; this simply has a plain hole drilled

The Design and Use of Drifting Tools

by W. M. Halliday

WHEN having to reproduce square, hexagon, or polygonal shaped holes in a number of components, recourse to what is known as the " drifting method " will often offer the greatest practical advantages, convenience, and economies to the toolmaker.

This method comprises the use of a short hardened steel drifting tool, formed on its critical sizing portions exactly to the same shape and dimensions of the hole required in the part. This tool will be forced through a drilled hole previously machined through the component. A straightforward cutting action will be derived with a correctly designed and constructed drift, and very accurate results may be obtained.

Advantageous Applications of the Drifting Method

Use of this method will prove especially convenient and time saving in cases where only a very small number of parts has to be produced, and for which the provision of special pull-through type of broaches would be uneconomical and prohibitive in initial tool costs.

The method will be found extremely useful in the manufacture of prototype components. Generally with such articles only one or two pieces will be required, or the hole shape may be of an exceedingly unusual character which cannot easily be reproduced by any of the ordinary machining methods. Use of ordinary broaches will of course be entirely ruled out on account of their high cost, and the absence of finality in respect of such hole shapes or sizes.

Very often holes or openings will be required which are too small in size, or too complex in shape to allow them to be easily machined by customary cutting tool methods on, say, the milling or slotting machines.

Short of using drifting tools of the character shortly to be described, a very considerable amount of hand tooling by chipping, filing and scraping may be entailed in their successful reproduction. Such unsatisfactory methods of hole formation are extremely costly in labour time, and moreover if several parts have to be produced, there may be some errors present in respect of the sizes of the respective holes.

By using drifting tools, which very often will be of a very simple design form, a great deal of hand tooling and filing may be completely eliminated.

Furthermore, as will be appreciated when filing such hole shapes it will be necessary to make up test plugs of the same external shape as the hole required, by means of which the progress of the hole may be gauged from time to time as filing proceeds.

By using drifts all such inspection and gauging requirements may be obviated, since the tool itself is in effect a master as regards size and form.

Drifting is also an extremely accurate method enabling really intricate hole shapes to be formed within precision limits. Successively drifted components will be found to be identical in all critical respects with each other.

The method is also very economical on account of the relatively low initial tool costs involved in the manufacture of the simple drifting tool. Once this has been made up the actual formation of the holes may be performed with greater speed, closer accuracy, and with far less trouble than would be possible with filing, or even certain forms of machining.

Usually with machined holes it will be necessary to set-up the workpiece a number of times during the operation to reproduce the proper contours on the hole. It will also be necessary to provide the machinist with an accurate scribed outline on the side faces of the work before machining or filing can be commenced. In the preparation of such a guiding outline considerable time and trouble may be required, because it will have to be marked out with very close precision to prove of the maximum help to the machinist.

In addition, with both ordinary machining or filing methods costly gauges and testing plugs will be required for the use and guidance of the operator.

There is practically no limitation to the variety of forms and shapes of holes which may be produced inexpensively by drifting. It is essential however, that the hole be devoid of undercuts, or taper along its length, because the drift will only form parallel holes, except in special cases.

One very great practical advantage is that holes of considerable length may be formed with greater facility than is possible with machining or hand-tooling methods.

When the component is of slender proportions on the walls surrounding the formed hole, drifting will often be the most feasible production method available for minimising the risks of cracking or distorting such thin wall sections.

With a correctly designed drifting tool almost a pure cutting action is obtained. Therefore, when such a tool is properly applied there will be less strain inflicted upon slender surrounding walls than will occur during hand-chipping, or slotting machine operations.

In the hands of an experienced and careful toolmaker it will be possible to discern at an early stage whether too heavy a load is being applied to the job, or if too great a resistance is being offered to the progress of the drift. In such circumstances the tool would be instantly withdrawn, and the sides of the hole eased out a little by judicious filing.

When milling or slotting intricate hole shapes, it will often be difficult for the operator to judge whether the cutting action is clean and keen at all times. Thus the unobserved blunting of the cutter may impose greatly additional load upon

surrounding weak wall sections, and cracking or complete fracture of the component might ensue.

The Drifting Method

The blacksmith makes extensive use of hole drifts for producing shapes of an unusual form. A round hole will first be *punched* through a heated plate, after which a series of tapered drifts will be inserted into the hot plate to obtain the required form.

With this method there is no actual cutting or shearing of the metal, the drift acts solely as a kind of hob to deform the hot metal to the shape required.

It is an inaccurate process necessitating further machining of the hole shape. It does, however, give an approximate shape which can usually be machined or filed very easily and quickly to the required final shape when the component is cold.

This method too is only applicable to a few ductile metals such as steel, or wrought-iron which are capable of being freely worked in the hot state.

In contrast to this method, precision drifting of holes of the kind under consideration in this present article is a very *accurate* one. The drift is essentially a cutting tool applied without any heating of the work. The shape of the drift on the critical cutting portions must be very accurately determined and the size and shape of this portion will be faithfully reproduced on each successively drifted component.

The drifted hole will have very smooth surface finish, it will be accurate in respect of all dimensions and parallelism, and shape.

The drift will normally be forced gradually into the work, at a speed depending upon the grade of material, and the amount of metal to be removed.

The drift may be pressed into the workpiece by means of a hand or power operated press, and by hammering.

Whilst most engineers will have some experience and knowledge of the actual drifting process many will possess little understanding of the basic design and constructional requirements of such tools.

Several of the more important design principles and considerations will be described for the guidance of engineers wishing to make fuller use of this versatile and economical method of hole formation.

Basic Design Features of the Drifting Tool

One of the most common drifting requirements is that of opening out a round drilled hole to produce a perfectly square shape. This may have sharp or slightly rounded corners.

If the corners in the finished square hole can be provided with a slight radius so much the better as this will materially reduce the cutting load on the tool, and will also enable the critical cutting edges to maintain their original keeness for much longer periods of use.

The diagram, Fig. 1, illustrates a very simple form of square drift required for meeting the above purposes. This will serve to depict some of the essential design characteristics to be attained.

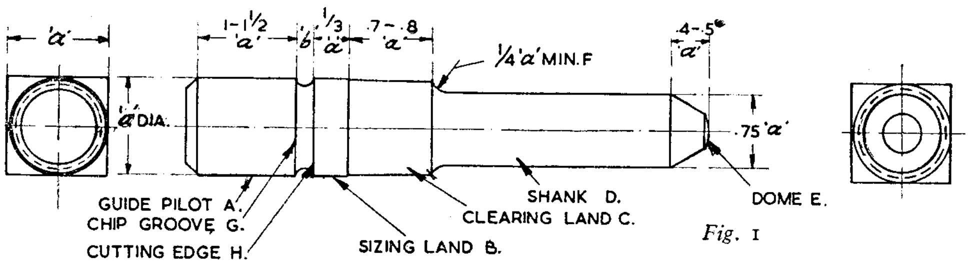


Fig. 1

This tool is made from standard square section cast-steel bar, and comprises the following elements.

A is the guide pilot at the front of the tool. This is turned cylindrical and perfectly parallel, and should be a free sliding fit within the plain round hole in the work. A clearance of between 0.002 and 0.004 in. may be allowed on the diameter of this pilot portion. The pilot should be amply chamfered or rounded at the leading end after the fashion depicted.

This portion of the drift performs several important functions. It serves as a guide for the whole tool in its passage through the hole in the workpiece. It also prevents the drift from tilting out of square with the axis of the hole. By centralising the tool in this way the cutting action is equalised and the load distributed evenly on all four cutting edges.

The sizing land *B* is squared exactly to the same dimensions as those on the finished hole. This land portion must be formed exactly concentric with the pilot.

As will be noted the land is of short length, being perfectly parallel throughout.

Immediately behind this sizing land and integral with the body of the tool is the clearing land *C*. This is usually tapered on each side at a very small angle tapering down away from the sizing land.

Integral with the body is the cylindrical shank *D*, which portion must be formed perfectly concentric with the remainder of the tool.

The extreme end of the shank is formed conical in shape, with a side angle of approximately 60 deg. The tip of this coned portion is slightly domed as shown at *E*. If the drift is to be employed in conjunction with a fly-press such doming may be omitted, but it will be found most helpful when the tool has to be actuated by hammer blows.

(*To be continued*)

An Adjustable Angle Plate

by S. F. Herridge

THIS useful adjustable angle plate will assist when grinding, drilling, shaping, milling or jig boring, etc. Illustrated in Fig. 1 is the one which has greatly assisted the writer over a long period of years, and is made of mild-steel throughout. Its special feature is that it can be moved through a wide arc suitable for marking-out and machining alike, and set either by using a protractor or sine bar. To assist further, Fig. 2 shows that provision is made for a setting plate register which can either be a parallel strip or angle iron for quick setting purposes.

A plate prepared to $5\frac{5}{8}$ in. × 3 in. × $\frac{5}{8}$ in. will provide the baseplate, while two machined rectangular pieces, $1\frac{1}{2}$ in. × $\frac{5}{8}$ in. × $1\frac{5}{8}$ in., will provide the hinged portion. Next, mark out the circle and the relative holes shown in Fig. 2. Holes which mate when assembled on swivel arms, such as the pivot point and slot (15/32 in. radius, see Fig. 3) with its retaining screws, are best drilled and tapped in one and clearance in the other, and marked to correspond when assembling complete; thus, the $\frac{3}{8}$ in. diameter pivot hole will be reamed square to the inside faces. The 2-B.A. hole drilled and tapped at 45 deg. provides a positive register, preventing the $\frac{3}{8}$ in. diameter pivot dowel turning and causing undue wear in the hole. With the hinged portion

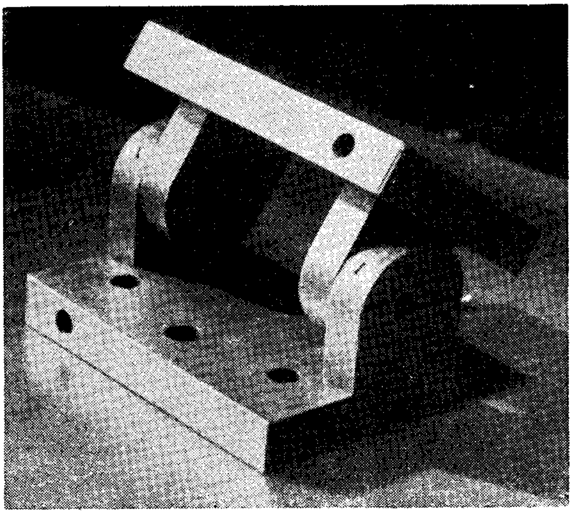


Fig. 1

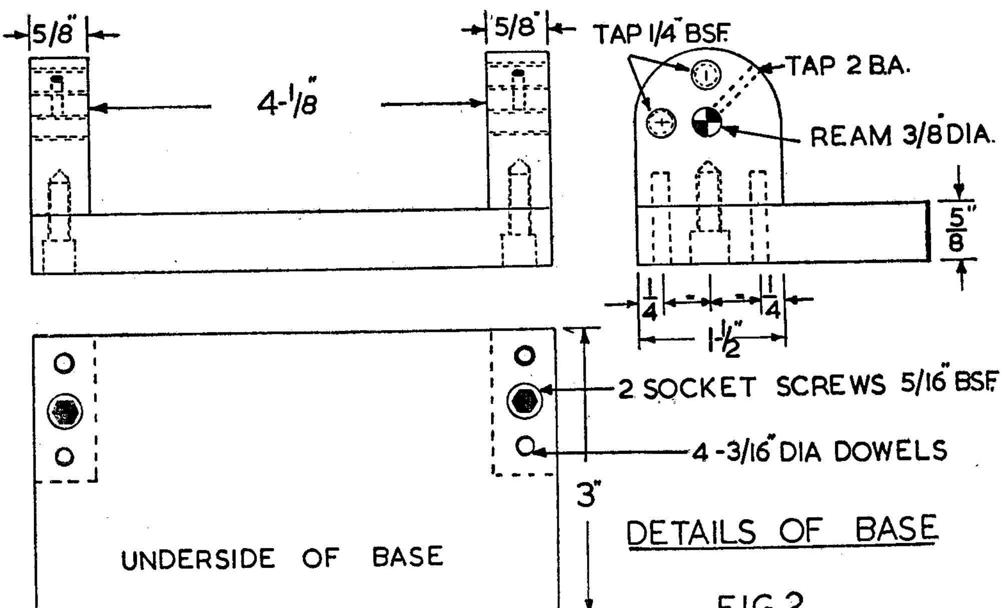
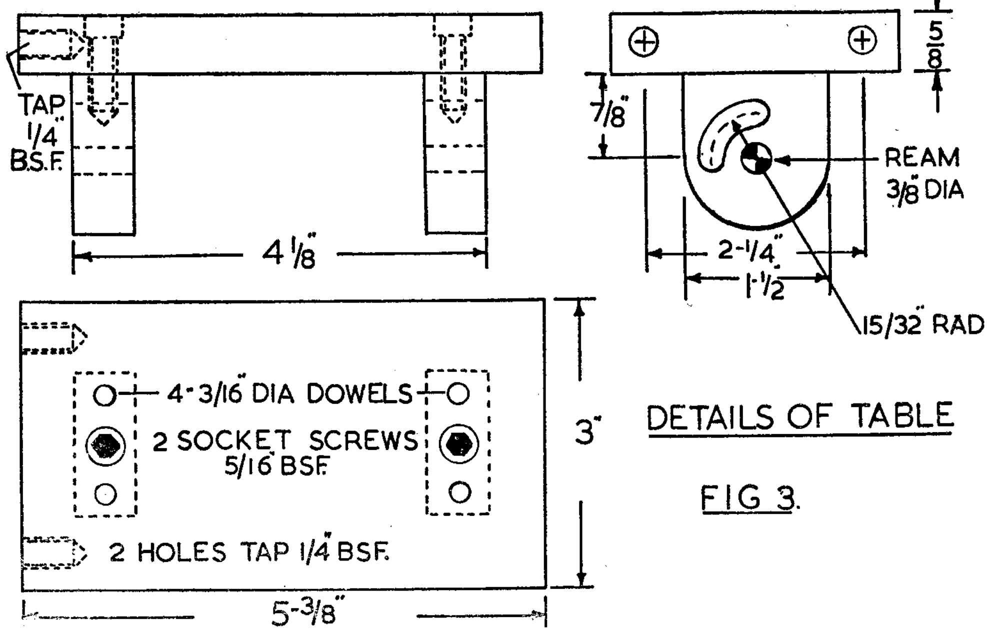


FIG 2



DETAILS OF TABLE

FIG 3.

ready for assembly, mark out and drill the relative position of the screw holes in the baseplate. It is not recommended at this stage to dowel these together until the table portion is partially complete.

The Table

This is prepared similarly to the base, with the additional drill holes for the register when quick setting is required. These holes are tapped ¼ in. B.S.F. The swivel arms are set in from the side edges at either end of the table. The 4⅛ in. size must be strictly adhered to, and again only the socket screw holes drilled and fitted.

Fitting

Now with the base and table screwed respectively with swivel arms, assemble them together with a ⅜-in. diameter pivotal dowel. With a smearing of oil on the inside faces on the mating swivel arms, adjust their position by tapping with a light hammer and finally tightening the screws right up. Next, the dowel holes can be drilled and reamed. With the angle-plate complete, you will find instances where holes will be required for clamping purposes on the table; however, these can be added as the situation arises. The clearance tapping and reaming sizes mentioned are tabulated for convenience as under :—

Tap Size	Tail Size	Clearance Size
2 B.A.	No. 26	13/64 in.
¼ in. B.S.F.	No. 5	17/64 in.
5/16 in. B.S.F.	Letter G	21/64 in.

Reamer Size	Drill Size
3/16 in.	No. 15
⅜ in.	Letter U

Register of Model Railways

THE Model Railway Club has just issued a National Register of Model Railways; it consists of a 13-page booklet containing the names and addresses of owners of model railway layouts in most of the standard gauges up to 5-in.

The list is arranged in order of the counties, alphabetically set out, together with the times at which the owners are prepared to receive visitors by appointment. Areas outside the English counties extend to the Isle of Man, Northern Ireland, Scotland and Wales, and upwards of 190 layouts are listed.

The publication of this register is timely, in view of the fact that many model railway enthusiasts from overseas are expected to visit Britain this year. It is also to be welcomed as a means of promoting many new friendships among modellers everywhere.

Copies of the register can be obtained from R. C. Panton Ltd., 162a, Strand, London, W.C.2, price 1s. each including postage.

Novices' Corner

Making a Drill Chuck Arbor

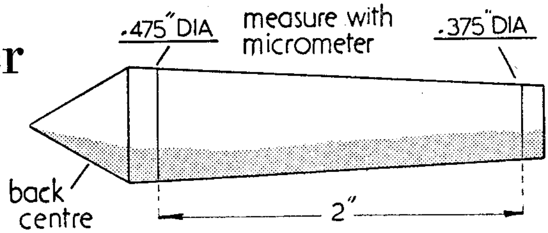


Fig. 1. *Measuring an external taper*

NOWADAYS, when buying a drill chuck for use in the lathe tailstock, it is not uncommon to find that a corresponding arbor is unobtainable or that those available are not of the right size of Morse taper to fit the lathe. In these circumstances, rather than suffer a long delay, it is better to machine an arbor in the workshop, for there is no great difficulty in doing this and an accurate fitting can be made if a methodical way of working is adopted.

Although mild-steel will serve quite well in the small workshop for this purpose, better wearing qualities will be obtained if an alloy steel is used such as can usually be obtained from the car-breaker. Discarded axle shafts are excellent material, and although they are tough they are quite easily machined with ordinary high-speed steel tools. Some workers appear to find that silver-steel is apt to be brittle ; nevertheless, it is commonly used for making slender D-bits and other small tools, and we have never known it to fail. This variety of carbon steel is, therefore, suitable for making chuck arbors which are of robust proportions and are not subjected to heavy stress.

Measuring Tapers

As the taper at either end of the arbor will be turned by setting-over the lathe top-slide to the correct angle, the value of these two tapers must first be determined.

External tapers can be measured sufficiently accurately for the present purpose by using the method illustrated in Fig. 1.

As an example, take the lathe back centre which, let us say, is No. 1 Morse taper and mark two lines with the grease pencil 2 in. apart ; then measure with the micrometer the diameter at these two points. Measurements obtained in this way were 0.475 in. and 0.375 in. The total taper is, therefore, 0.1 in. in 2 in., or 0.05 in. for the half-taper measured from the centre-line ; this represents a taper of 1 in 40 which, according to a reference table, corresponds to an angle of 1 5/12 deg. Those who use trigonometry will ascertain from a table of sines that the value 1/40 is equivalent to an angle of 1 deg. 26 min., or approximately 1 5/12 deg. Although it is rather more difficult to measure internal tapers, approximate values can readily be obtained and, as will be seen later, these will serve well enough for the preliminary machining operation.

As shown in Fig. 2A, the internal calipers are adjusted so that they will just fall by their own weight to the end of the tapered portion of the bore in the chuck body. After a mark has been made with the grease pencil level with the top of the chuck, the calipers are withdrawn and the setting measured with a micrometer.

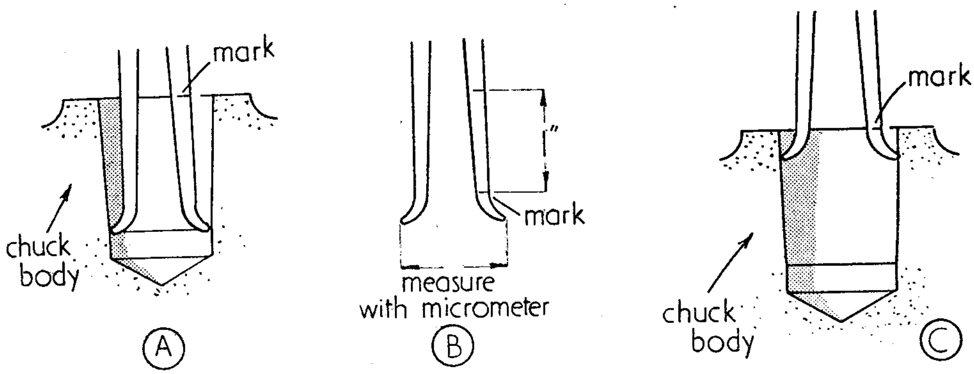


Fig. 2. *Method of measuring an internal taper*

Next, as in Fig. 2B, make a second mark 1 in. below the first and then take a measurement across the upper part of the bore at this level, as illustrated in Fig. 2C. Actual measurements obtained in this way were 0.564 in. and 0.627 in., giving a total taper of 63 thousandths of an inch per inch, or approximately 1 in 16.

The taper measured from the centre-line is, therefore, 1 in 32 corresponding to an angle of

1 4/5 deg. It might be thought that these tapers could be measured directly by means of a protractor ; so they can, but suitable protractors fitted with an attachment for measuring small angles are expensive instruments ; moreover, it is more instructive, and usually much cheaper, to make use of simple measuring tools whenever possible.

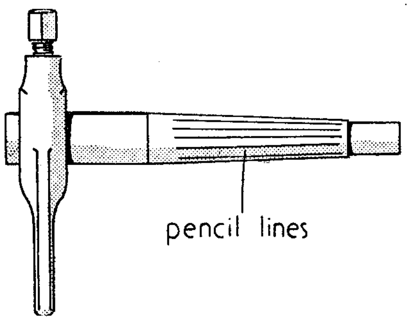


Fig. 3. *Marking the work for fitting the taper*

Machining the Tapers

At the start, a sketch is made showing the lengths of the two tapered portions of the arbor and allowing enough space between them so that a spanner or tommy bar can be used for removal. The length of the tapered part fitting in the chuck is determined by the construction of the chuck itself, and for the other portion the lathe back centre can be copied.

The material is now set to run truly in the four-jaw chuck, and, after the end has been faced, a centre is formed with a centre drill ; this operation is then repeated on the other end of the work.

A carrier is next secured to one end of the bar and the work is mounted between the lathe centres and driven by the catch-plate.

The taper that fits in the tailstock is machined by setting the top-slide over to an angle of slightly less than 1½ deg. with reference to the angular scale engraved on the top-slide base.

There are, however, two important points to be observed : the top-slide pivot must be accurately fitted so that the slide will rotate without moving sideways, and the tool must be set at exactly centre height, otherwise a straight-sided cone will not be formed.

To obtain a good finish, light cuts should be taken, and, as hand-feeding is employed, the lathe should be run at high speed to offset any irregularity in the feed. In addition, a continuous supply of cutting oil should be fed to the work, preferably by means of a brush and carrier, as described in a previous article.

When the arbor has been machined to some 50 thousandths of an inch oversize, it is removed from its mounting and tried in the tailstock barrel. To carry out this test, a series of parallel lines are drawn with a soft, lead pencil along the taper, as shown in Fig. 3 ; if the arbor is now given a partial turn in the barrel and then withdrawn, the obliteration of the pencil lines will show where contact has been established and in what direction the top-slide must be reset to afford any necessary correction of the taper angle. When resetting the top-slide, it is advisable to attach the test indicator to the slide so that it bears on the work and will thus indicate the slightest alteration of the slide's setting. In this way, resetting of the slide can be much more accurately controlled than by merely making use of the top-slide graduations. Once the exact angle of taper has been found by obtaining uniform obliteration of the pencil lines, the arbor can be reduced in diameter to enter the tailstock barrel for the required distance, but, as shown in Fig. 3, the end portion of the work should be turned parallel to afford a hold for the lathe carrier when the arbor is reversed for turning the second taper. The taper to carry the drill chuck can be machined in an exactly similar manner or, if preferred, the Morse-tapered end can be engaged in the lathe mandrel and the second taper then turned. For this purpose, the work should be secured in the mandrel by pressing it inwards and at the same time applying a wringing movement with the aid of a lathe carrier.

On no account should the arbor be hammered into place, and, at most it may be lightly tapped in when protected by a piece of wood. To avoid displacing the arbor when turning the chuck taper, only light cuts should be taken and a slow rate of

(*Continued on page* 487)

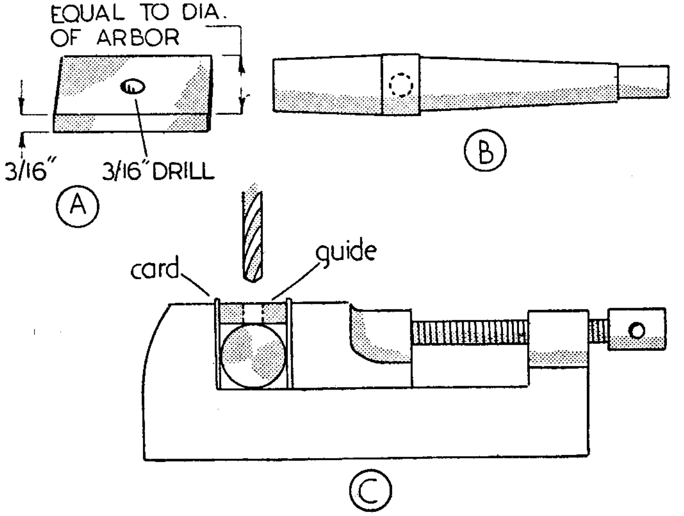


Fig. 4. *Cross-drilling the finished arbor. "A"—the drill guide ; "B"—position of cross-hole ; "C"—Arbor with guide gripped in the vice for drilling*

POLISHING A BASEBOARD

by S. F. Weston

ONE often sees a perfectly good model, well made and finished in good style, marred by being mounted on a comparatively rough board, either painted or varnished. Had the board been polished, the value of the whole would have been enhanced.

It is proposed, in this article, to deal with french polishing only so far as it concerns mounting-boards for models. This is quite easy work and it is not until larger and more elaborate subjects with panels, mouldings and projections are to be polished that higher skill is required. All that is necessary for polishing mounting-boards is a little patience and obedience to a few simple rules.

Wood

It is better to use wood such as mahogany, teak, walnut or oak, but, unfortunately, today these are very expensive. A good substitute is found in bass wood—this is a soft wood of fine grain and takes a good polish. Whatever wood is used, finish off by completely mounting the model so as to get all holes correct, then take the model off the board and surface same with glass-paper, finishing with No. 0 or preferably No. 00 if obtainable.

Staining

It is best to use a spirit stain, as this does not raise the grain of the wood as does water stain. It is a trifle more difficult to control, as it dries much quicker. It can be obtained, in various colours, from any colourman's or cabinet-maker's supply stores.

Filling

When the stain is quite dry, cover the surface with a fluid mixture of plaster of Paris, rub in well across the grain of the wood, and, when thoroughly dry, rub over the surface with a coarse rag in the direction of the grain.

Oiling

The next step is to give the work a coat of raw linseed oil ; this brings out the grain of the wood, as will be seen if the harder figured woods have been utilised.

Polish

Like the stain, the polish can be obtained ready made at a colourman's. Often a coloured polish is available so as to combine staining and polishing in one operation.

It must be carefully remembered that the work of polishing consists of spreading a small quantity of polish over a large surface. Keep this most important point in mind. Your ends will not be served by trying to do the work quickly by using too much polish at once. If this is done, the work becomes streaky and sticky. It is here that patience is needed.

Rubber

The polish is applied by means of a rubber. This consists of a small piece of cotton-wool, about the size of a plum, with two or three layers of linen, free from starch. Charge the rubber by holding the cotton-wool to the neck of the polish bottle and inverting for the fraction of a second, and repeat until the cotton-wool is damp—but not soaking with polish. Then cover up with the linen and lightly twist the ends of same, whilst slightly pressing the surface of the rubber in the palm of the hand. It will be found that the polish has worked through and the surface of the linen is damp with it.

Polishing—First Coat

Bear in mind that once the charged rubber touches the surface of the work it must be kept in motion the whole time, and on no account left stationary on the surface to be polished. Start, say, at the top left-hand corner of the board and by small circular motions work down to the bottom right-hand corner. This method of using the rubber ensures the whole surface being covered. Repeat the operation again and again, not forgetting the edges of the board. As the rubber becomes drier it may be inclined to stick. If this occurs, put a spot of raw linseed oil on the tip of a finger and just pass it over the surface of the rubber.

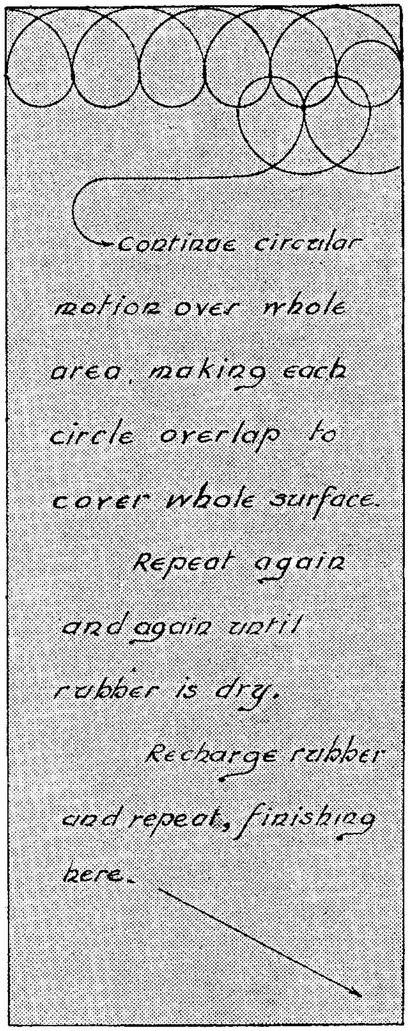
When your rubber is dry and the polish transferred to the wood, the rubber can be recharged, and the process repeated until you notice that gradually the surface is becoming covered. When this point is reached, get a small bottle, and mix a little polish with an equal amount of methylated spirit—this is known as "half and half." Now charge your rubber with this mixture and you will find the surface becomes more even and brighter. If, when it is necessary to add a little oil to the rubber, you see the rubber marks smear on the polished surface, you are going on satisfactorily ; just continue, don't rub too hard and you will find that the oil smears die out and gradually disappear, leaving a good polished surface. As the surface becomes more polished, gradually lengthen the circular motion of your rubber until you finally finish up with straight strokes along the grain of the wood. Now lightly cover to keep dust off the work and lay it aside to harden.

Polishing — Second Coat

After the first coat has been allowed at least 24 hours to harden, no doubt some blemishes will show, due to the polish having sunk in more in one place than another. Lightly dust the work with a soft duster and then lightly rub the whole surface with No. O or OO glass-paper, which paper has been previously oiled with raw linseed oil. This rub down is necessary to even the surface, but must not be too heavy ; again dust the surface and commence applying the second coat. This is done in exactly the same way as the first coat, but using the "half and half" mixture all the time. A little oil on the surface of the rubber will be necessary, but keep this to the minimum, as oil tends to spoil the gloss. It cannot be too often repeated that each rubber of polish must be rubbed out dry ; failure to do this will only give unsatisfactory results. The surface should now show a good even polish and should be stood aside to harden.

Polishing — Spiriting Off

Care must be taken with this final operation. A clean rubber is used and is lightly damped with spirit only. After the work has been dusted and inspected, and found to be satisfactory, then the spirit is applied using light strokes in the direction of the grain of the wood. Dull streaks will show in the rear of the rubber, which should quickly evaporate and disappear gradually. Such streaks become less and less and the work assumes a glass-like surface. Allow the work to harden for 48 hours before handling.



It will be seen from the above outline of polishing that there is nothing difficult, but one cannot too strongly impress and repeat :

(1) You must spread a little polish over a large surface by slowly rubbing until your rubber is empty.

(2) Make sure your rubber is empty before recharging.

(3) Use as little oil as possible.

(4) Never let your rubber rest still for a moment on the surface being polished.

(5) Never soak your rubber with polish.

(6) Be patient—polishing takes time.

(7) Screw a block of wood on the underside of the baseboard to facilitate handling.

Novices' Corner

(*Continued from page* 485)

feed used with the lathe running at high speed.

When the taper has been accurately fitted in the manner already described, the arbor is removed by lightly tapping on a length of rod inserted in the hollow mandrel.

To finish the arbor and to provide a means of removal from the tailstock barrel, either spanner flats can be filed on the central portion, or a cross-hole drilled to take a tommy bar.

The easiest way, perhaps, of drilling this hole truly is to make a small drilling guide to fit between the vice jaws together with the arbor. As shown in Fig. 4, a piece of flat brass or steel is filed to a width equal to the diameter of the plain portion of the arbor ; after the drilling centre has been marked-out with the jenny calipers, it is first centre-drilled and then drilled to size with a $\frac{3}{16}$ in. diameter drill. The guide, together with the arbor, is next secured in the machine vice with a strip of thin card on either side to distribute the pressure evenly and so afford a firm hold for both parts. The use of a guide in this way will ensure that the drill passes through the centre of the work, and, to give a workmanlike finish, the two ends of the cross-hole are lightly countersunk with a small centre drill.

Another, and even easier, way of making the guide is to turn the end of a length of rod to the same diameter as the workpiece : after an axial hole has been drilled from the tailstock to form the guide hole, the guide itself is cut off to length with a parting tool.

Queries and Replies

Enquiries from readers, either on technical matters connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a stamped, addressed envelope, and addressed : "Queries Dept.," THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases, the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of an outside specialist or consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query ; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.

No. 9897.—Effecting a Metal Joint P.H.B. (Sanderstead)

Q.—Over the course of years the pillar of my Champion ½ in. drilling machine has become loose in its base. It wobbles, but will not come out altogether. I think the pillar is just driven into the base, but the method of fixing is not obvious. Can you suggest a method of securing it ? There is a relatively small amount of metal surrounding the pillar.

R.—The most satisfactory remedy for a loose pillar on your drilling machine would be to extract it, bore out and rebush the seating in the base. You state, however, that the pillar will not come out altogether. If that means that it is not possible to remove it at all, it would be very difficult to effect a satisfactory repair, but one method which has been used with a certain amount of success in such cases, is to run in a saturated solution of sal ammoniac round the joint. This causes a chemical reaction in which the metal will expand and tighten up the joint. It should not be used in the region of any working parts, as the action is approximately equivalent to rusting, and would, in these circumstances, do considerable harm.

No. 9898.—Wire Straightening F.P. (Handforth)

Q.—I wish to straighten some 8 s.w.g. wire, the lengths required being about 2-4 ft. Is there any simple way of doing this ? The wire is in a 2 ft. diameter coil. My equipment consists of a 3 in. centre lathe driven by a ¼ h.p. motor.

R.—A fairly simple way of straightening wire is to run it in the lathe in lengths as long as can conveniently be handled, and to apply bending force in two directions simultaneously such as by using two pieces of metal or hard wood with holes drilled through them, large enough to take the wire, and set at a slight angle in opposite directions held either by hand or in the toolpost of the lathe. The wire should be rotated at fairly high speed, and of course, kept lubricated so that it does not jam in the holes. The blocks should be traversed fairly rapidly along the length of the wire from the chuck towards the outer end, and after one or two passes, the wire will emerge perfectly straight.

No. 9896.—Electric Heating for Workshop H.G.S. (Lightwater)

Q.—Will you please advise me regarding the heating of my small workshop. The building is 8 ft. × 8 ft. × 7 ft. 6 in. high, built in 4½ in. brick with asbestos roofing, situated at the rear of the house and protected from west winds except the south, one window on south and one on north side. I propose to use one of the 2-kW 220/230-V convection heaters now offered for sale in the advertisement columns of THE MODEL ENGINEER and controlled by a thermostat. Do you consider this arrangement an economical one with current at less than one penny per unit ? Would it be any advantage to use two 2-kW, 110-V heaters wired in series, in preference to the former arrangement ? I am not seeking a high temperature, but just enough to keep the humidity constant.

R.—We consider that a 2-kW heater with thermostat control would be quite economical for heating your workshop. With regard to your suggestion for connecting two heaters in series, we are extremely doubtful whether the temperature attained by the heater would be sufficiently high to be very much use at all, but the question could really only be settled by experiment. In the case of thermostat control, the heater would be cut out as soon as a sufficiently high temperature had been obtained and, therefore, would only be in intermittent use, so that the current consumption would not be unduly high. In any resistance heater, the actual quantity of heat produced is bound to be strictly dependent on the amount of current expended.

No. 9903.—Dynamo Suppressor
J.A.McR. (Troon)

Q.—I should be most grateful for advice on the following. I have a d.c. dynamo supplying current for house lighting and this causes interference with the radio (a battery set) by humming, and needs suppressing. The dynamo is 110 V, d.c. and normally gives 3 A (though it is a big machine and capable of giving about 10 A). It is a two-pole shunt machine running at about 900 r.p.m. The armature is about 4 in. diameter by 6 in. long and the commutator has about 40 segments. I think it came from a Petter lighting set originally. It charges a 110-V. Nife battery, but the cells are not big enough to supply the light for long without the dynamo running, and are more in the nature of a " voltage regulator " than for storage.

R.—Suppression mav be obtained by connecting two condensers of between $\frac{1}{2}$ and 1 Mfd. across the dynamo brushes. Two condensers are used, coupled in series. The mid-point connection is connected to earth, the remaining ends being connected to each respective brush of the dynamo. As the characteristics of dynamos will vary considerably, there will have to be a certain amount of trial and error by increasing or decreasing the condenser capacity. As the voltage is only 100, ordinary paper condensers may be used.

No. 9894.—Conversion of Engine to Compressor
R.E.M. (Southampton)

Q.—Will you please inform me now to convert a 500 c.c. four-stroke side-valve motor-cycle engine into an efficient air compressor.

R.—A 4-stroke side-valve engine can be converted to an air compressor in a very simple manner, provided that a moderate efficiency is required. The simplest way is to use both the existing valves as inlet valves, or blank one of them off entirely, and the valve or valves to be used in this way should have the existing springs replaced by very light ones, so that they will lift readily on the suction stroke. The delivery valve can be fitted to the valve cap or sparking-plug hole, though in the latter case, the size of valve which may be accommodated is limited. A simple ball-valve can be used for delivery, preferably loaded with a light spring, but a mushroom valve would be more efficient, especially if made about the same size as the inlet valve. You do not state how high a pressure is required from this compressor, but with the engine in its original form, the highest pressure which can be obtained will be that equal to the compression pressure of the engine when used as such. For higher pressures, it will be necessary to increase compression ratio, that is to say, reduce the space above the piston at top dead centre, which may be done by machining away the cylinder flange or the top of the crank-case, if sufficient metal has been left on these points. Alternatively, it would be permissible to bolt a plate or distance-piece on the top of the piston for taking up the dead space.

No. 9905.—Balancing a Moulding Head
J.H.T. (Ham Richmond)

Q.—Could you advise us on circularly balancing a moulding head? The one in question is a thick block of chromium steel 5 in. diameter × 2 in. thick which has two jaws directly opposite one another holding blades, and sliding in and out by a screw. These blocks travel round at 7,000 revs. per min., and if they are even slightly heavier one side than the other, they set up a terrible vibration which would, if allowed to run, cause great damage to the spindle moulding machine, or fly off. At the moment, we balance them on a mandrel that runs on ball-races set in V-blocks, but if a piece of dirt gets into the bearings, it puts the balancing out. We have tried covered ball-races, but they are too stiff.

R.—The balancing of a high-speed moulding head of the type suggested should, properly speaking, be done on a dynamic balancing machine, but as you have apparently found static balancing satisfactory in the past, we suggest that the best way to carry this out is to roll the mandrel, with the head in position, on carefully levelled knife edges or narrow strips of hardened steel, such as steel rules, with carefully polished edge, and set uo in small clamps, or some form of stand, so that they can be levelled up in themselves and with each other. This is a much better method than rolling the mandrel in ball-races, as there is usually a certain amount of friction even in the best ball-bearings, particularly if they happen to be loaded with oil or grease, and as you suggest, there is also the possibility of grease or dirt loading the bearing unequally. It is, of course, extremely important that the mandrel itself should be perfectly true and in balance when tested separately.

No. 9901.—A German Motor
R.J.B. (Salisbury)

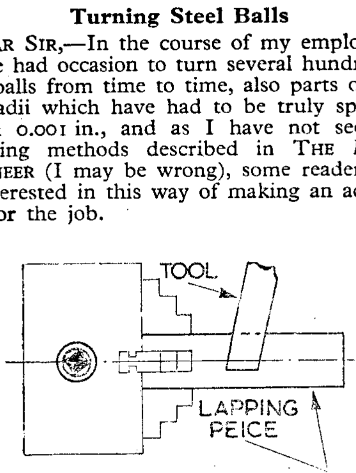
Q.—I have a German motor, and should like to know what the marking on the plate E-220 V means in full. This is a d.c. motor with laminated magnets, so I am going to run it from a.c. mains. Could you tell me the best way to drop the voltage from 230; I have tried several ways such as part of an electric fire, but it does not take the amps, as this motor takes 1.55 A.

R.—The " E " on the nameplate means E.M.F. volts, and that the motor is for a seven-hour rating. The E here means the maximum volts for the motor. With continental practice it is quite usual for a maker to wind a given frame for two voltages rather than wind the motors separately for their respective voltages. The field coils will be connected in parallel for the low voltage and in series for the higher voltage. As your motor is wound for d.c. there is a doubt as to its ability to work on an a.c. voltage. As a trial, connect the field coils in parallel and in series with the brushes. It should now run after some fashion, but a winding change may be necessary. If this motor is shunt wound, rewinding of the field coils will be necessary and even then the result may not be what is required.

PRACTICAL LETTERS

Turning Steel Balls

DEAR SIR,—In the course of my employment I have had occasion to turn several hundreds of steel balls from time to time, also parts of balls and radii which have had to be truly spherical within 0.001 in., and as I have not seen the following methods described in THE MODEL ENGINEER (I may be wrong), some readers may be interested in this way of making an accurate tool for the job.



First, a piece of tool steel is rough ground by hand to the radius of the ball or radii to be turned, the more accurately this is done the quicker it will be to finish the tool.

Now, a piece of stock (steel will do though brass is better) is turned to the finished diameter of ball desired, and whilst still in the lathe is smeared with lapping compound, the tool is now held on this diameter at about 5 deg. angle and worked back and forward running the lathe fairly fast (see sketch). If the tool has been roughed out fairly accurately a correct radius will soon be produced, but here a warning! Where almost a complete ball has to be formed the writer has found by sad experience that it is best to exert more pressure on, I will call it, the *sides* of the radius when lapping the tool so that a slightly elliptical radius is formed. This enables the tool to be moved from side to side a little and stops it cutting "all round" at once, usually with dire results such as the job trying to climb over the top of the tool. In use best results are obtained by setting the tool a trifle low 5-10/1,000 in. and running on the slowest possible speed with a dribble of good slurry, and for a sphere—to move the tool gently from side to side by tapping the saddle handle with the hand. It will be appreciated that any radius required may be accurately formed by this method and the finished job is very pleasing indeed.

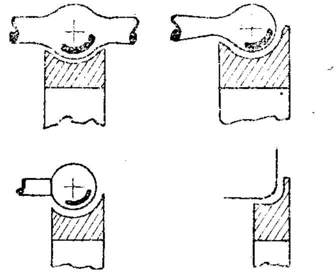


Diagram of various tools

Yours faithfully,

Alton. H. J. GATES.

Making a Twin-cylinder Pump

DEAR SIR,—On looking over THE MODEL ENGINEER for October 12th last, I was at once struck with the steam pump described by Mr. J. I. Austen-Walton. I have no use for such a pump, but it looked such a workman like job and bore such a close resemblance to the full-sized article that I just had to make one up.

I did not follow the directions *precisely* and here is why and how. The port block I made of really hard phosphor-bronze, also the steam chest and cover. To keep the steam port holes equidistant from the exhaust holes I made a little jig and it came in useful afterwards as will be seen. For the "serpent's nest" I annealed short lengths of copper pipe and plugged one end with a bit of asbestos, stood them up in the vice and put lead wire down them. I then played the flame on them till they were full of lead, giving them a few raps to get rid of air-bubbles, etc. Care and patience, with occasional excursions into the profane at last enabled me to get them looking as nice as the writer's drawing. I did not silver-solder them in place, but used a blowpipe solder that melts a *little* below my old friend "Easyflo." I did not put it on with a trowel but even so I found two steam ports had solder in them. So I rigged the before-mentioned port jig and found the solder was of no depth, the drill dropping easily into the pipe.

A compressed-air test showed all clear and correct. The steam pistons I made of dural and final turning them on their own rods, as they are there for keeps. The pump plungers are of Tufnol and have to be made to come off when required for erecting. I reduced the rod to 3/32 in. diameter and then put a tiny steel washer on, then the plunger, and then a 3/32-in. nut sunk in the body of the plunger. Piston-rods. I did not like the idea of drilling a tiny hole through crosshead and rod and fitting a taper pin and then trying to fit the pin the right way round *inside the trunk*. So I fitted the crossheads as is often done in full-sized practice, and that is with a small set-screw. I used No. 12 Progress.

The valve spindles are 3/32 in. and call for screwing 7 B.A. which is 0.0984 in. and would not go in the 3/32 in. hole in the steam chest cover. Well, I never was one for splitting hairs, so I just filed 0.005 in. off the top of the threads with a fine file and carried on peaceably. Also, I drilled all clearing holes except one, a few thous. larger than called for. If the spigots are a good fit, then they and the one hole locate the covers, etc., perfectly and the extra clearance saves fitting-shop English in the erecting.

Here is a quick method of reducing the ·48 bolt-heads to the size called for. I mounted a grinding spindle in the slide-rest and having a 4 in. × ¼ in. medium-grain wheel running at 4,000 r.p.m. The bolts were screwed fairly tightly into a little brass collet and to save the time and trouble of having to take two hands to shift the index peg each time I made a ball-ended peg so I could rotate the mandrel with one hand while the other racked the saddle along. My mandrel plate wheel is steel, so no damage ensued. Time about two minutes per bolt, floor to floor. For the valve levers I made one and checked it for correctness, then case-hardened it and filed and drilled four to it and cased them also.

The clack-boxes and banjoes I made as per drawings but shall vary the pipe runs, as I hope to fit a proportionate sized air bottle on the delivery to stand in the same position as in the big sets. I am also fabricating a box bed to mount the whole thing on. I have had the steam and water ends running light on compressed-air and it works perfectly.

Yours faithfully,
Luton. ERNEST W. FRASER.

Camera Construction

DEAR SIR,—I have read with interest Mr. Russell's article and Mr. Andrew Todd's letter on the above subject. During the last twelve years I have used most types of camera, including home built ones, for the photography of models and small objects.

The most suitable camera for this purpose is, in my opinion, most suitable also for many other branches of serious photography. I should like to construct a smaller version of the modern American view camera, to the following general specifications :

The plates used should be 3½ in. × 2½ in., as they are large enough for most purposes and not too expensive.

Camera front of light alloy, giving rise and vertical swing. Back, also light alloy, providing swing and carrying conventional viewing screen.

These should be connected by a bellows of generous length and mounted on a base of steel angle, along which both back and front could be moved by friction movement.

The inconvenience of using bellows is more than outweighed by the facility for using front and back swings to position the lens below the centre of the plate, thus enabling the correction of verticals when photographing down on to models. Also, the generous extension allows one to get really close up for photographs of details and individual components.

The lens and shutter, bellows and plate holders should be bought. The plate holders are difficult to make up satisfactorily in thin material, and at half a guinea each are not so expensive.

If we can persuade a competent model engineer to do the designing, we shall have a camera, fairly simple to construct, versatile and really efficient.

Yours sincerely,
Southampton. COLIN R. ADAMS.

Casting in Rubber Moulds

DEAR SIR,—Being a keen model engineer, and therefore only too concerned with rising prices, and having to use "substitutes," I would like to draw your attention to a new process being employed within the jewellery industry, namely, the casting of low melting point alloys into heat resisting rubber moulds. During my recent experience of this development in a business capacity, I have formed the opinion that this method of production can be very easily applied to the manufacture of small engine and aircraft castings, to considerable advantage of the model engineer, especially from the point of view of cost. Having taken the trouble to mention the matter to one company in particular, I find they are only too keen to undertake work within the realms of model engineer's requirements.

I would point out that this method of casting into rubber is highly specialised, requiring considerable control, but the degree of detail which can be obtained is such, that when compared with pressure die-castings, etc., a much lower costing is obtained. I personally am able to advise on certain low melting point alloys that may be employed to advantage, and with the co-operation of the trade, sample quantities of castings to suit model engineers can be undertaken. May I, through the medium of THE MODEL ENGINEER, ask your co-operation by drawing your readers attention to the above, especially the retail trade, with a view to their enquiries being given full attention, to their own, and every model engineer's satisfaction.

Yours faithfully,
Upper Norwood, S.E.19. DENNIS N. LICENCE.

Twist Drill Grinding

DEAR SIR,—Mr. Carr's letter in the March 8th issue reminds me that I have not yet made any answer to Mr. Arnot's criticisms published in the January 18th issue.

I do so now—if only to put on record that I am not intimidated by his evidently deep knowledge of the theoretical side of the business. Myself—as is no doubt obvious—I have no such knowledge. Classics rather than conics have been my occupation, and I view the whole business of model engineering with the keen delight of a (like myself) stout Cortez scanning a new and untried territory.

In this frame of mind I made a gadget for touching up my drills. It worked—*pace* Mr. Arnot—quite surprisingly well. It seemed to me that maybe some other amateur-amateur might like to try making one. For such folk alone I drew it out and wrote it up.

En passant, though no doubt theoretically impossible, I ground an inch or so off a drill without getting the twin-tipped point Mr. Arnot envisages. Actually, I have an idea that the compound angle at which the drill is presented to the stone, together with the twisting motion, does all that is factually necessary. However, as I say, I wouldn't be knowing the theoretical answer to that one !

Yours faithfully,
Dalston, Cumberland. KEITH CAMPBELL.